United States Department of the Interior
BUREAU OF LAND MANAGEMENT

SEPTEMBER 1980

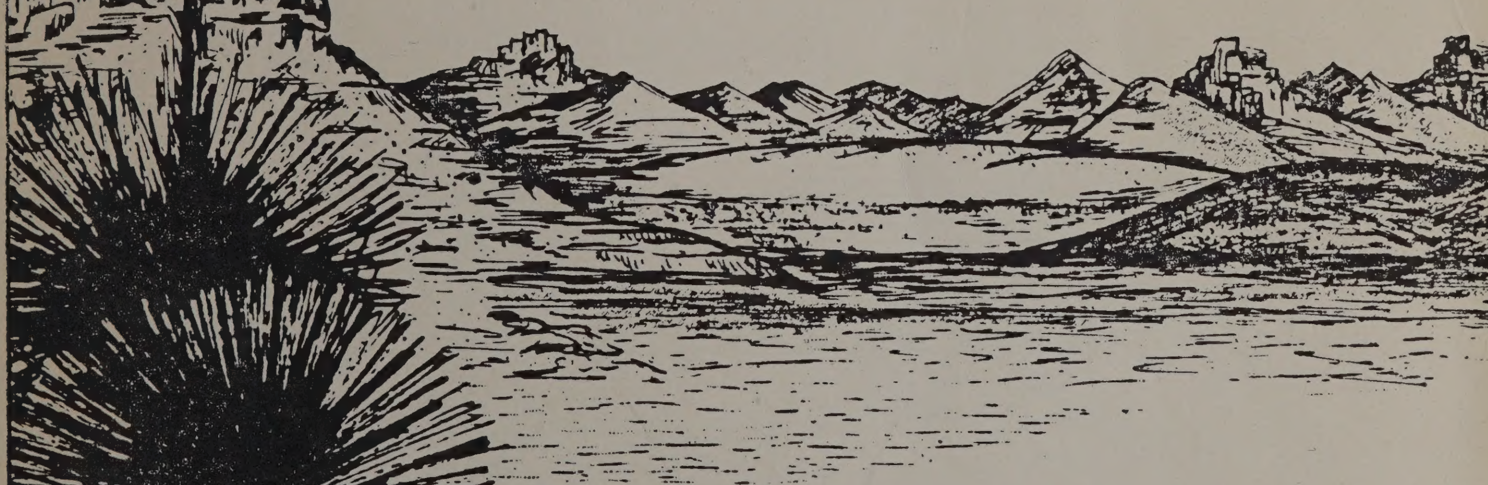
Final Environmental Impact Statement and Proposed Plan

APPENDIX

•Volume G (revised Jan 1982)

APPENDIX XIV: GEOLOGY - ENERGY - MINERALS (G-E-M)

APPENDIX XV: ENERGY PRODUCTION AND UTILITY CORRIDORS



CALIFORNIA DESERT CONSERVATION AREA

California Desert Conservation Area

Final Environmental Impact Statement

and Plan

APPENDIX XIV

GEOLOGY-ENERGY-MINERALS

APPENDIX XV

ENERGY PRODUCTION AND UTILITY CORRIDORS

PREFACE

The Geology-Energy-Minerals Appendix XIV, Volume G of the California Desert Plan, has been revised to incorporate new data, to correct errors in the original appendix, and to meet the demand for the information contained in this document. Some of the previous concerns which were considered include the value of iron deposits, poorly cited references and vague texts and tables.

The new information is most evident in Part 2, "Preliminary Analysis of Economic Geology, Mineral Commodities, and Related Socioeconomics of the California Desert Conservation Area." Generous contributions by industry sources, new publications, and a more thorough review of the literature permitted substantial revisions to this section. Several additional commodities, which are significant in the CDCA, have been analyzed in the revision of this section.

The list of commodities analyzed is not complete, however. Additional information will be analyzed as reports are written on various areas in the CDCA. These reports will be written by Bureau of Land Management geologists and are known as Geology-Energy-Minerals (GEM) Resource Area reports. A description and example of a GEM Resource Area report is included in this appendix.

Appraising mineral resources is an emerging science. A final, once and for all "inventory" of any mineral resource is not possible. Mineral reserves and resources are dynamic quantities and must constantly be appraised. As known deposits are exhausted, unknown deposits are discovered, new extractive technologies and new uses are developed and new geologic knowledge indicates new areas and new environments are favorable for mineral exploration. (Paraphrased from: J. McKelvey, 1976, Mineral Perspectives: U.S. Geological Survey Prof. Paper 940, p. 5.)

We hope this document explains what the Bureau of Land Management has done and what it plans to do.

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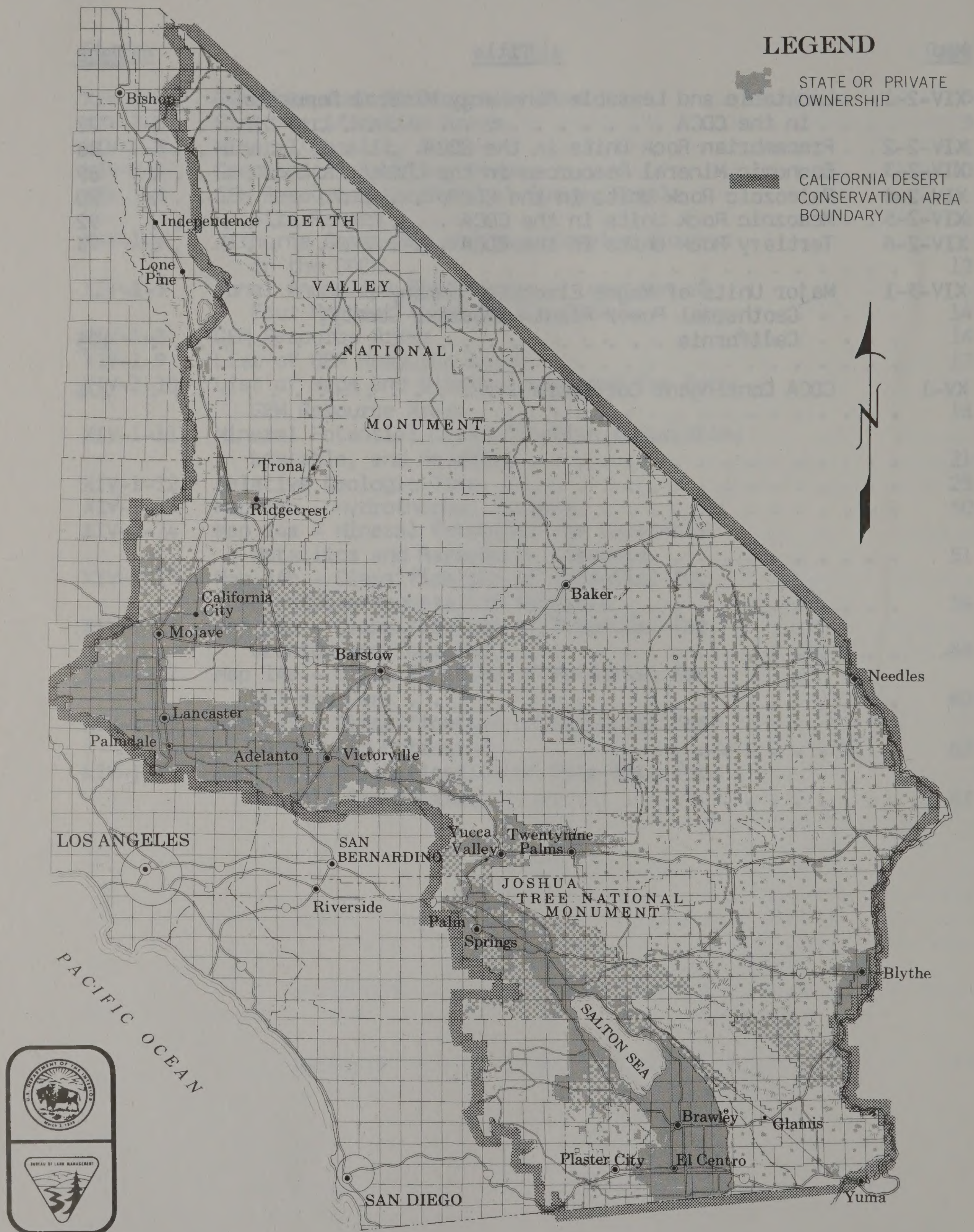

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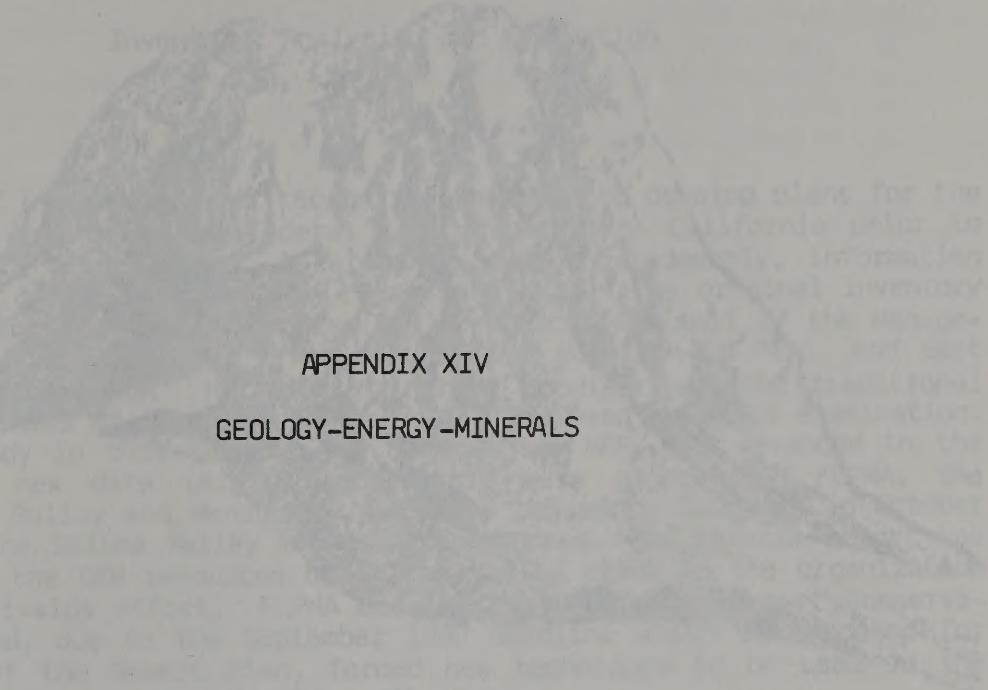
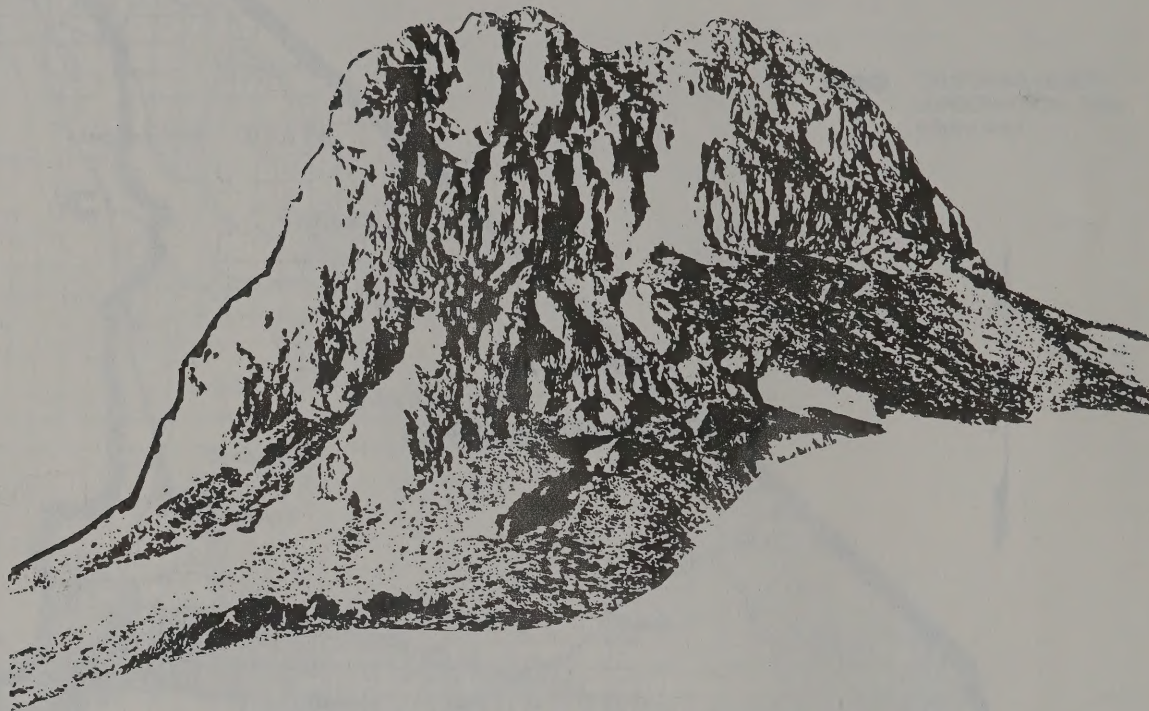


APPENDIX XIV

GEOLOGY-ENERGY-MINERALS



APPENDIX XIV

GEOLOGY-ENERGY-MINERALS

Part 1

Inventory, Analysis, and Evaluation

INTRODUCTION

The Bureau of Land Management recognized the need to develop plans for the multiple-use management of Federal land in southern California prior to the California Desert Plan. In order to plan knowledgeably, information was required on the various resources found here. The original inventory of data on Geology-Energy-Minerals (GEM) resources was part of the Management Framework Plans (MFPs) on the Yuha, Red Mountain-El Paso, and East Mojave planning areas. The first of these studies used the traditional inventory methods of literature examination followed by field examination. The last study in this series, the East Mojave MFP, had advanced to the point where new data (e.g., geophysical) were generated. FLPMA, the Federal Land Policy and Management Act, was passed by Congress in October 1976, when the Saline Valley MFP was in progress. An interim report was completed on the GEM resources of Saline Valley prior to the organization of the desert-wide effort. FLPMA created the California Desert Conservation Area and, due to the September 1980 deadline which it mandated for completion of the Desert Plan, forced new techniques to be used in the inventory of GEM resources in this vast area.

METHODOLOGY

To provide information on GEM resources for the development of the California Desert Plan a two-phased work program was initiated. This program combined geologic concepts and working hypotheses with modern methods of evaluation for an integrated analysis of the CDCA. Phase I gave a synoptic view of the geologic environment and its potential for energy and mineral deposits. Phase II focused more on specific areas or commodities, permitting a less generalized evaluation of the GEM resources of the CDCA. The program, shown below, included data gathering, analysis, and the synthesis of results.

Phase I

1. Literature search and compilation
2. Lithology, structure, and mineralization study
3. Verification of selected areas in the field (intermittent)
4. Study of lineaments on remotely-sensed images
5. Geostatistical study of mineral endowment
6. Paleontological studies

Phase II

1. Literature search and compilation
2. Geochemical survey
3. Geophysical survey
4. Tonal anomalies (hydrothermal alteration) survey
5. Verification of information in the field
6. Industrial minerals study
7. Independent panel evaluation of mineral endowment
8. Geostatistical study of mineral endowment
9. Mineral economics study

For optimum efficiency, the two phases and their components were to be completed sequentially, but delays caused some of the tasks to be done simultaneously. Time was gained by doing tasks simultaneously, but efficiency suffered. The studies discussed in this appendix are available for perusal at the BLM California Desert District Office in Riverside, California.

Phase I Tasks

1. The literature search and compilation was the first task undertaken in the GEM resources program. It was continuous in that updating and addition of information took place at any time. Published and unpublished reports containing geologic, structural, geomorphic, geochemical, geophysical, paleontologic, geothermal, mineralogic, mining, and other similar information in these fields that were directly or indirectly related to the CDCA were continuously sought and reviewed. Professional papers, bulletins, maps, and other publications of the U.S. Geological Survey (USGS), the U.S. Bureau of Mines (USBM), the U.S. Department of Energy (DOE), the California Division of Mines and Geology (CDMG), the California Division of Transportation (Cal-Trans), and the Southern Pacific Land Company were researched for useful information. For each such report used, a form was completed and the data inputed into the DPS computer to form a computerized bibliography; Figure XIV-1-1 is the GEM Resources Bibliography Form. This computerized bibliography, along with other Desert Plan data, is available at the BLM offices in Riverside and Sacramento. Other computerized data banks, such as GEOREF, Computerized Resources Information Bank (CRIB), Minerals Availability System (MAS), and Mineral Industry Location System (MILS), were searched. Professional journals, company reports, and Masters and Ph.D. theses were studied. Pertinent and useful literature, published and unpublished, was either included in the BLM California Desert library, or copies were made and included in the respective area file.

2. The lithology, structure and mineralization study was initiated to build an understanding of the geologic environment(s) of the known mineral deposits in the CDCA, the relationship between the different types of rocks, the mineralization, and the structural controls. Geologic models of mineralization were developed using data available in the earliest stages of the program: 1:250,000 geologic maps; the mineral occurrences as given in the U.S. Bureau of Mines computerized

Figure XIV-1-1

G-E-M RESOURCES BIBLIOGRAPHY FORM

Reference No.____________ Author(s):________________

Year:________ Title:________________________

Source:________________________________

Country(s):____________ State(s):____________

County(s):____________ BLM District(s):____________

BLM Res. Area(s):____________ Plan. Unit(s):____________

Region:________________________________

CATEGORIES

0. Maps
1. Areal Geology - general
2. Areal Geology - maps & charts
3. Economic Geology - general
4. Economic Geology - leasable
5. Economic Geology - locatable metallic
6. Economic Geology - locatable nonmetallic
7. Economic Geology - salable
8. Energy - coal
9. Energy - general
10. Energy - geothermal
11. Energy - oil, gas, oil shale
12. Energy - nuclear
13. Energy - solar
14. Engineering & Environmental Geology
15. General Geology
16. Geochemistry - applied
17. Geochemistry - theoretical
18. Geochronology
19. Geomorphology
20. Geophysics - applied
21. Geophysics - theoretical
22. Historical Geology
23. History
24. Hydrogeology & Hydrology
25. Mathematical Geology
26. Mineralogy & Crystallography
27. Paleontology - general
28. Paleontology - invertebrate
29. Paleontology - paleobotany
30. Paleontology - vertebrate
31. Petrology - general
32. Petrology - igneous
33. Petrology - metamorphic
34. Petrology - sedimentary
35. Remote Sensing - geophysical
36. Remote Sensing - imagery
37. Stratigraphy
38. Structural Geology
39. Surficial Geology
40. Tectonics

KEYWORDS:

____________ ____________

____________ ____________

____________ ____________

MILS data bank in the CDMG files; and other information on types of mineralization. Areas with similar geologic and structural characteristics were identified and delineated on a map. In some models the age of the rocks involved were also important. Following are examples of mineralization models: tungsten placers; hydrothermal replacement lead-zinc mineralization in carbonate rocks; contact metamorphic iron mineralization; and zeolites in altered Cenozoic tuffs.

3. Verification of data in the field was also a continuous, though intermittent, project completed by BLM geologists in both phases. This task had more than one purpose. Reliable field-collected data provide the best geologic information. Field review was also needed to verify information on geology and minerals and to add new data from the verified area. In addition, field work permitted the Bureau to verify results of the contract studies as these studies were completed. Ideally, all areas of potential GEM resources defined in Task 2 above, as well as those identified in the paleontological study, remote sensing surveys, and geostatistical study, should have been verified in the field. However, the shortage of time and personnel did not permit this and, again, areas for further follow-up activities had to be selected. The selection was based on how much area could be covered in the field, where data were most needed, including areas of existing or potential conflict with other resources, and what types of new data were needed in a given area (see Figure XIV-1-2). Information gathered in the field, along with some data from the literature, were compiled on Mineral Locality Record forms (Figure XIV-1-3).

4. The lineament study was based on the concept that linear structural elements and/or fractures in the Earth's crust could act as conduit for mineralizing processes for certain types of mineral deposits. The relationship between mineral deposits, lithology, and linear structural elements has been observed in many parts of the U.S., including the CDCA. Existing data from different remote sensing surveys were used to identify linear structures. They included: Landsat imagery, high and low altitude photography, and CDCA-wide contoured gravity and airborne magnetic data. Lineaments were identified, compared, and evaluated for their reliability. The following statistical criteria were used to categorize these lineaments: the number of lineaments, their relationship to the known lithology, and known mineral deposit occurrences. These criteria were defined and interpreted as potential mineral resources. The product of this work was a technical report and several CDCA-wide maps. This work was performed for BLM under contract by General Electric Company's Space Division.[1]

5. The geostatistical study in Phase I was also based on existing data in a desert-wide approach. Geologic, geophysical, and mineral occurrence data available in published or unpublished literature were compiled. Data on 3,009 occurrences included location, mineral

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[1] General Electric Space Division, 1978, Landsat Lineament Study: BLM Contract YA-512-CT7-224.

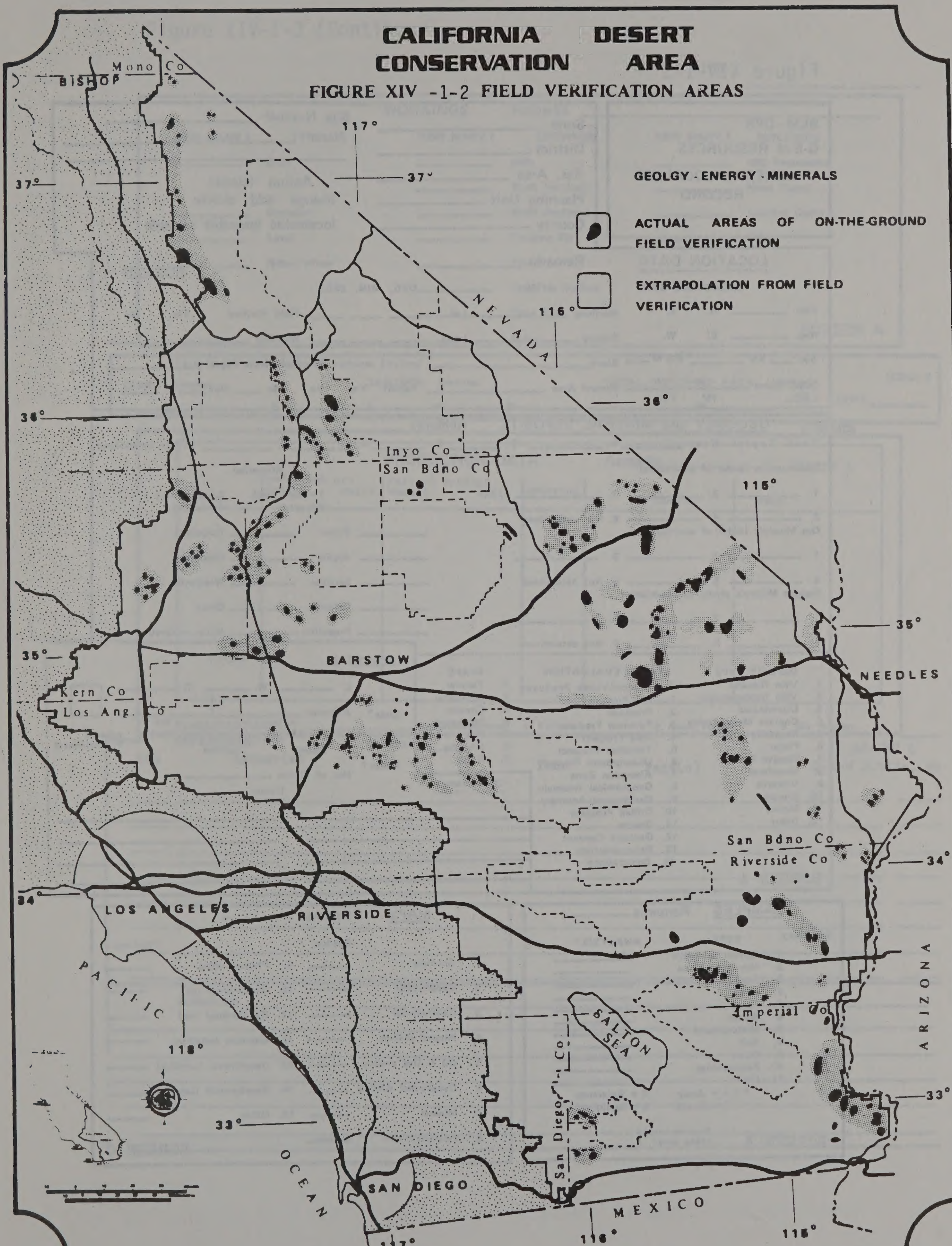
CALIFORNIA DESERT
CONSERVATION AREA
FIGURE XIV -1-2 FIELD VERIFICATION AREAS
GEOLGY - ENERGY - MINERALS
ACTUAL AREAS OF ON-THE-GROUND FIELD VERIFICATION
EXTRAPOLATION FROM FIELD VERIFICATION
Mono Co
BISHOP
117°
37°
116°
NEVADA
36°
Inyo Co
San Bdno Co
115°
35°
BARSTOW
NEEDLES
Kern Co
Los Ang. Co
San Bdno Co
Riverside Co
34°
LOS ANGELES
RIVERSIDE
PACIFIC
OCEAN
ARIZONA
Imperial Co
SALTON SEA
San Diego Co.
118°
33°
SAN DIEGO
MEXICO
117°
116°
115°

Figure XIV-1-3

BLM - DPS
G-E-M RESOURCES
MINERAL LOCALITY RECORD

State ________
District ________
Res. Area ________
Planning Unit ________
County ________

Site Number ________
Name ________

Action (circle)
change add delete
locateable leaseable saleable

LOCATION DATA

Remarks ________

SCREEN 1

CADASTRAL GRID

Twp. ____ N. S.
Rng. ____ E. W.
Sec. ____ ¼¼ ____ B & M ____
Quad. Name ________ 15′ 7.5′

UTM

Northing ________
Easting ________
Block ________
Mineral Area ________

DEG. MIN. SEC.

Lat. ____ ____ ____
Long. ____ ____ ____
Report Yes No

Field Verified Yes No
Recorder ________
Field Note Pages ________
Mo ____ Day ____ Yr ____

SCREEN 2

GEOLOGY and MINERAL DEPOSITS

Remarks ________

Rock Types: Host: ____ 1. ____ 2. ____ 3. ____ 4. ____ 5. ____ 6. Not determined

Commodities (order of abundance)

1. ____ 2. ____ 3. ____
4. ____ 5. ____ 6. Not determined

Ore Minerals (order of abundance)

1. ____ 2. ____ 3. ____
4. ____ 5. ____ 6. Not determined

Gangue Minerals (order of abundance)

1. ____ 2. ____ 3. ____
4. ____ 5. ____ 6. Not determined

Alteration

1 = very weak 3 = moderate
2 = weak 4 = strong

____ Silicic ____ Carbonate
____ Argilic ____ Oxidation
____ Sericitic ____ Weathering
____ Chloritic ____ Other
____ Propylitic ____ None observed

DEPOSIT TYPE

1. Vein (fissure)
2. Vein (replacement)
3. Diseminated
4. Contant Metamorphic
5. Evaporite
6. Placer
7. Massive Sulfide
8. Stratiform
9. Volcanic
10. Breccia
11. Marine
12. Other

STATUS EVALUATION

0. Intermittent Producer
1. Past Producer
2. Producer
3. Potential Producer
4. Raw Prospect
5. Trenched Prospect
6. Underground Prospect
7. Alteration Zone
8. Geochemical Anomaly
9. Geophysical Anomaly
10. Drilled Prospect
11. Gossan
12. Geologic Concept
13. Reconnaissance
14. Occurrence

SHAPE

1. Tabular
2. Lenticular
3. Circular
4. Stockwork
5. Pipe
6. Irregular
7. Other

SCREEN A

SCREEN B

SIZE (metres)

L ____ W ____ D ____

Lode? Attitude ____ strike ____ dip

enter H if horizontal

ACTIVITY
Active Inactive

Placer? No. of Claims ________

Claim Name

Owner

________ ________
________ ________
________ ________
________ ________

SAMPLES

Remarks ________

How Many

TYPE

1. Stream sediment
2. Hvy Mnrl Conc
3. Rock
4. Chip
5. Core
6. Dump
7. Underground
8. Soil
9. Water
10. Paleontology
11. Other

ANALYSIS *

* (A = Assay R = Reference
Q = Quant S = Semiquant)

Geochem sample taken here? # ________

SCREEN 3

MAPS

Remarks ________

	Ref.No.		Ref.No.
1. Geologic	____	9. Photogeologic	____
2. Geophysical	____	10. Geophysical (air)	____
3. Geochemical	____	11. Geochemical (air)	____
4. Mineral drilling	____	12. Geologic (satellite)	____
5. Oil & Gas drilling	____	13. Geophysical (satellite)	____
6. Geothermal drilling	____	14. Geochemical (satellite)	____
7. Mineral	____	15. Other	____
8. Property/claim	____		

SCREEN C

Figure XIV-1-3 (Continued)

UTM ____________

WORKINGS Remarks ____________

HOW MANY ?	TYPE	HOW MANY ?	OPENINGS	HOW MANY ?	BUILDINGS
______	Drift	______	Adit		Mill Foundation
		______	Shaft (vertical)	______	Head Frame
______	Crosscut	______	Shaft (inclined)	______	Loading Chute
______	Level	______	Prospect Pit	______	Other
______	Raise / winze	______	Trench		
		______	Stope to Surface		
		______	Open Pit		
______	Stope	______	Other		

SCREEN 4

Total length of underground workings (metres) ______

DUMP: (metres) L ______ W ______ D ______

TAILINGS: (metres) L ______ W ______ D ______

TOTAL DISTURBED AREA: (metres) L ______ W ______ -OR- area ______

SCREEN D

PRODUCTION DATA Remarks ____________ SCREEN 5

Year	unrefined ore amount units	refined product amount units	material	Reserves	Value

CLASSIFICATION: ______ Recommendation: 1. Follow up 2. Later review 3. No interest

REFERENCES: Remarks ______ SCREEN 6

No.	Author(s)	Year	Page(s)	G-E-M Biblio. No

REMARKS: ____________

commodity, name, and in some case geologic environment and production. Forty geological variables, such as rock types or contacts, on the California Division of Mines and Geology 1:250,000 scale geologic maps and one geophysical variable (Bouger gravity anomalies) were selected as meaningful for determining mineral potential. The entire CDCA was divided into 26,810 cells, 2 km by 2 km square. The 41 variables were quantified and recorded on a cell-by-cell basis. Data recorded in this fashion, together with mineral occurrence data, served as the basis for statistically classifying the cells according to likelihood of mineral occurrences. Of the several statistical methods tested, the discriminant function analysis (DFA) was chosen as best fitted for this work. The cells were thus classified with respect to occurrences of gold, iron, manganese, and a combination of copper-lead-zinc-silver occurrences. Occurrence data on over 40 other mineral commodities, including sand and gravel, limestone, carbon dioxide, and geothermal fluids, were tabulated but were not subjected to statistical analysis because of the small amount of the type of occurrence data. Results were presented in tabular form and in map form and were accompanied by a report. The study was performed for BLM under contract by Terradata Company of San Francisco.[1]

6. <u>The paleontological studies</u> were two separate studies, one for vertebrate and one for invertebrate fossils and were based on existing data. Their objectives were not only to compile most of the existing significant data, but also to evaluate known and potential site values and to suggest management guidelines for the resource. Evaluations were made for scientific, educational, and industrial potential of the resource. The results were presented as two separate reports, one for vertebrates and one for invertebrates, with their respective maps. The work was performed under contract by Professors Murphy[2] (invertebrates) and Woodburne[3] (vertebrates), both at University of California, Riverside.

Phase II Tasks

1. <u>The literature search and compilation</u> in Phase II were similar to and a continuation of the literature search and compilation in Phase I, Task 1. In Phase II references tended to be more site-specific than those used in Phase I. Bibliographic forms continued to be completed for references used, and the forms were entered into the computerized data bank.

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[1] Harbaugh, J.W., Kendall, G.R., Lambie, F.W., 1978, A geostatistical study for Geology-Energy-Mineral resources in the California Desert: Kendall Associates, BLM Contract YA-512-CT7-223.

[2] Murphy, M.A., 1978, California Desert Conservation Area Invertebrate Paleontological Resources Study: BLM Contract CA-060-CT7-2813.

[3] Woodburne, M.O., 1979, Fossil Vertebrates in the CDCA: BLM Contract CA-060-CT7-2814.

2. Reconnaissance geochemical surveys were done over four areas, shown on Figure XIV-1-4. Samples were collected by contractors and BLM personnel from 1,250 sites.

At each site, two samples of drainage sediments were collected. One sample was sieved at the site, and the -100 mesh fraction was collected, bagged, and given an identification number. The second sample was two to three kilograms larger and consisted of drainage sediment scooped from the immediate area of the site. The second sample was taken to the laboratory where, by panning, a heavy mineral concentrate was obtained and the magnetic minerals were extracted by a hand magnet. This formed the heavy mineral concentrate sample. Both the sieved and the heavy mineral samples were sent to the USGS chemical laboratory in Denver for semiquantitative spectrographic analyses for 65 elements.

The chemical results and sample locations were digitized and entered into the USGS data bank. Statistical analyses of some of the chemical data were done and anomalous results plotted and interpreted. Data on the sample and the sample location were entered on the form shown as Figure XIV-1-5.

3. Geophysical surveys were performed, under contract, on 10 selected areas (Figure XIV-1-6) using a gamma-ray spectrometer and a magnetometer mounted on a DC-3 flying at an ideal altitude of 400 feet terrain clearance. Different flight-line directions and flight-line spacings were selected on the basis of geologic structural trends and purpose of the survey. Surveys were performed by Geodata International, Dallas, Texas. Data from a 1975-1976 BLM survey over the East Mojave were available to supplement these data.

In addition to the BLM surveys, the Department of Energy (DOE) as part of the National Uranium Resource Evaluation (NURE) program contracted to have aerial magnetometer and gamma-ray spectrometer surveys flown for six 1° x 2° quadrangles. After completion of the California Desert Plan, the DOE released similar data for the rest of the CDCA. Also, the U.S. Geological Survey has released a detailed airborne magnetometer survey of the Needles 1° x 2° quadrangle.

4. The tonal anomaly (hydrothermal alteration) study identified areas of unusual color tone on Landsat imagery. The principle behind this project was to identify areas of unusual color tone on specially enhanced Landsat imagery. Unusual color tone could represent hydrothermally altered zones. Two different approaches were used, both based on enhancement of the data by using ratios of the spectral values of the Multispectral Scanner (MSS) bands. One contractor, General Electric,[1] used the following method: of six possible ratios, the best combination of three ratios was displayed on color composites to generate images that were photographically enlarged to 1:100,000 scale. The enlarged images were visually interpreted to delineate tonal anomalies. These anomalies were plotted, correlated with rock units, and interpreted as to their validity as areas of hydrothermal alterations.

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1 General Electric Co., 1979, Landsat Enhancement Project: BLM Contract.

CALIFORNIA DESERT CONSERVATION AREA

FIGURE XIV -1-4 GEOCHEMICAL SAMPLING AREAS, 1978

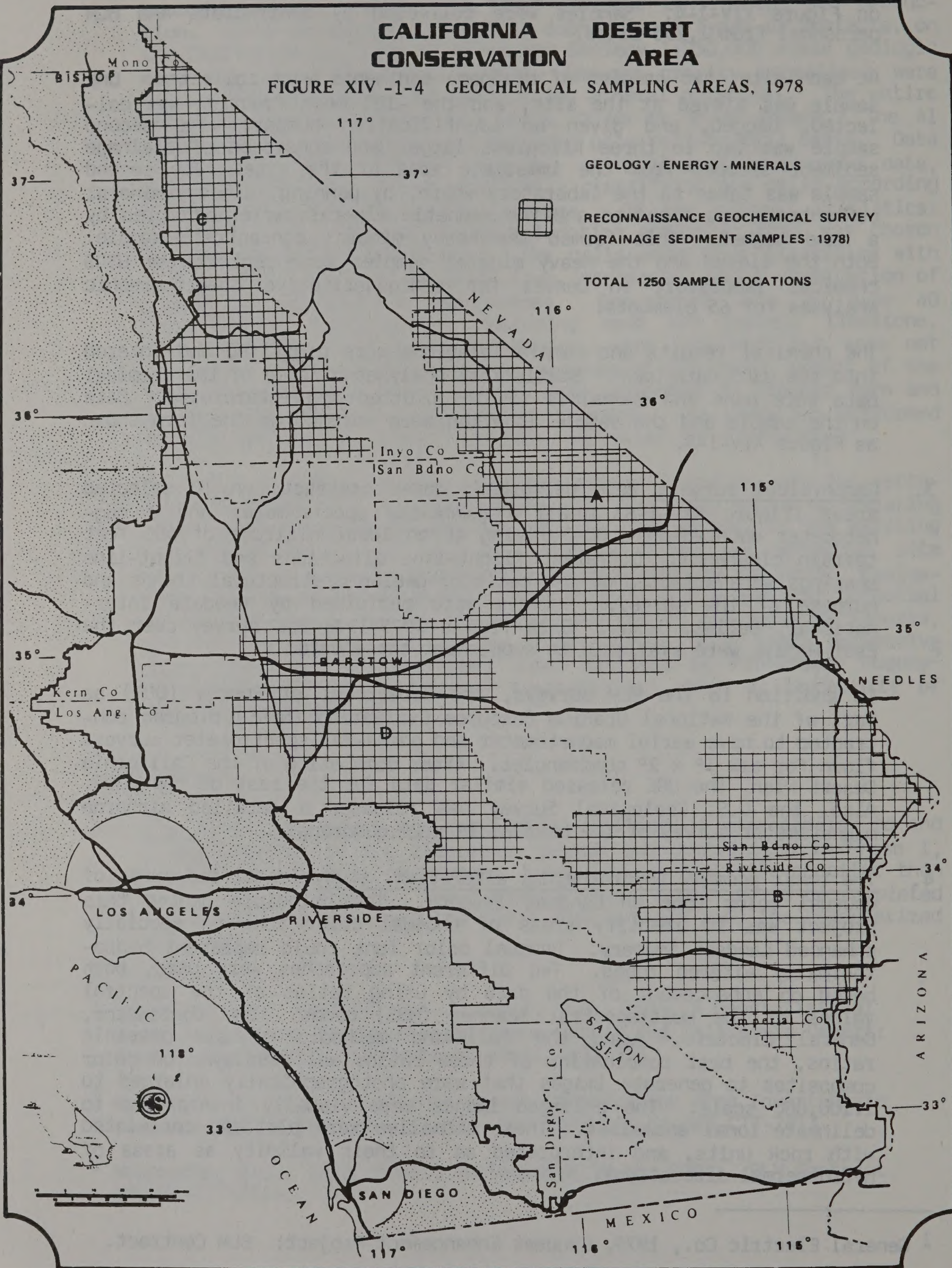


Figure XIV-1-5

BLM – DPS G-E-M RESOURCES
DESERTWIDE GEOCHEMICAL SURVEY
SAMPLE SITE RECORD SPRING, 1978

SITE NO. ______
STATE ______
COUNTY ______

DISTRICT ______
RES. AREA ______
PLAN'G UNIT ______

SITE LOCATION Rmks. ______

Cadastral Grid
Twp. ______ N. ____ S. ____
Rng. ______ E. ____ W. ____
Sec. ____ ¼¼ ______ B&M ____

UTM
Zone ______
Easting ______
Northing ______

Latitude and Longitude
Deg. Min. Sec.
Lat. (N) ____ ____ ____
Long.(W) ____ ____ ____

Quad. ______ 15′ ____ 7.5′ ____ Mineral Area: ______

SAMPLE DATA Rmks. ______

Date / Mo. ____ Day ____ Yr. ____
Sample Type: 1. 500 µm seived drainage sediment How many ? ______
2. Bulk sample for heavy mineral conc. How many? ______
Black sands taken ? ☐ yes ☐ no
3. Other ______ How many ? ______

Collector: ______
affiliation ______
Recorder: ______
affiliation ______
Hvy. Min. Conc: ______
affiliation ______

SAMPLE ENVIRONMENT Rmks. ______

Drainage Width (metres): ______ ☐ 1. Dry ☐ 2. Flowing
Drainage Type: ☐ 1. Open Valley ☐ 2. Canyon ☐ 3. Head of fan
☐ 4. Fan or bajada ☐ 5. Intermountain basin ☐ 6. Playa
☐ 7. Other ______
Drainage Pattern: ☐ 1. Dendritic (trunk) ☐ 2. Dendritic (tributary)
☐ 3. Braided ☐ 4. Other ______
Relief: ☐ 1. High ☐ 2. Moderate ☐ 3. Low ☐ 4. Flat

Activity (C= current) (P= past): ☐ 1. Agricultural ☐ 2. Mining
☐ 3. Industrial ☐ 4. Residential ☐ 5. Urban ☐ 6. None
☐ 7. Other ______

Weather: ☐ 1. Clear ☐ 2. Precipitation ☐ 3. Recent precipitation

Vegetation: ☐ 1. Barren ☐ 2. Sparse ☐ 3. Moderate ☐ 4. Heavy

Basin Size (mi ^{2}): ☐ 1. 0-5 ☐ 2. 5-10 ☐ 3. over 10

SEDIMENT CHARACTERISTICS Rmks. ______

Size: ☐ 1. Boulders ☐ 2. Gravel ☐ 3. Sand and gravel
☐ 4. Sand ☐ 5. Mud (silt and clay)

Color: ☐ 1. Black ☐ 2. Gray ☐ 3. Brown
☐ 4. Dark brown ☐ 5. Red ☐ 6. Red-brown
☐ 7. Yellow ☐ 8. Yellow-brown ☐ 9. Buff ☐ 10. White

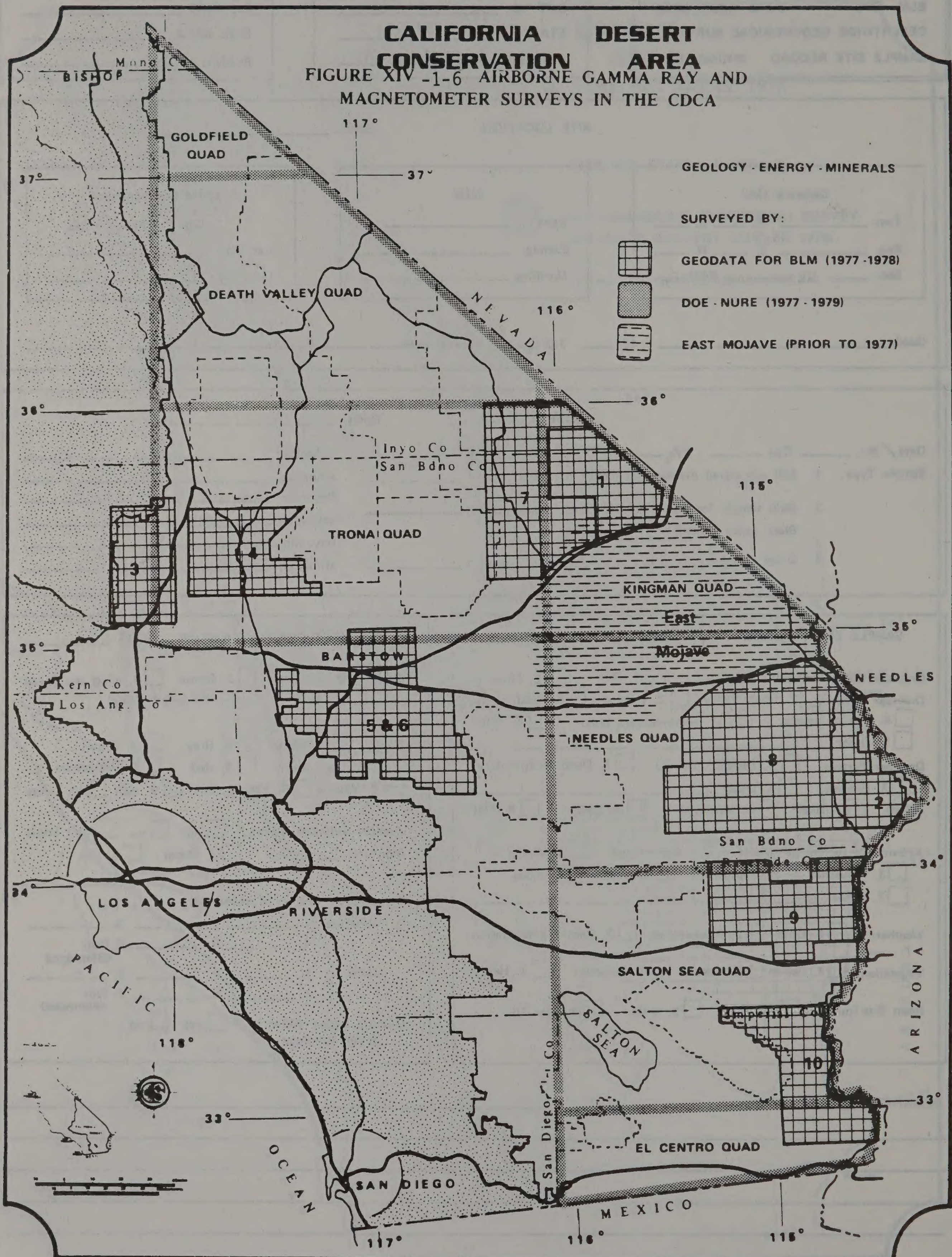
Aeolian Sediment Visible ? ☐ yes ☐ no ☐ don't know
Moisture: ☐ 1. Dry ☐ 2. Damp ☐ 3. Wet

Composition (in order of abundance):
Minerals: 1. ____ 2. ____ 3. ____
4. ____ 5. ____ 6. Not determined
Clasts: 1. ____ 2. ____ 3. ____
4. ____ 5. ____ 6. Not determined

Outcrop within 100 m ? ☐ yes ☐ no
If yes, lithology

REMARKS: ______

FIGURE XIV -1-6 AIRBORNE GAMMA RAY AND MAGNETOMETER SURVEYS IN THE CDCA



Stanford Remote Sensing Laboratory,[1] the other contractor, used the same six possible ratios and developed "Matrix Printer Maps" showing spectrally anomalous areas for the 5/4 ratio and for the 5/4 + 7/6 ratios. The anomalous areas were described, correlated to geology, and interpreted as to their potential for representing hydrothermally altered areas. Areas covered by these two studies are shown on Figure XIV-1-7.

5. Verification of data in the field continued during Phase II. Information from contract surveys was used as the surveys were completed. Each geologist prepared brief reports on the GEM resources of the areas in which he or she worked. Figure XIV-1-2 shows the areas where field work was done. The total area of potential mineralization extrapolated from this verification was approximately six million acres.

6. An industrial minerals study was initiated by forming a team of BLM geologists and mining engineers from offices within the CDCA under the immediate supervision of a BLM specialist in industrial minerals from the Denver Service Center. The sources of data for this study were published reports, BLM files, and mining companies. Data were compiled and plotted on a map at 1:250,000 scale. A brief report listed occurrences and deposits of industrial minerals and discussed the potential of future production.

7. The independent panel evaluation project was accomplished under contract with Terradata, which assembled a panel of 10 experienced geologists and prepared the material to be evaluated. The experts evaluated the potential for several types of minerals. Their evaluation was summarized in a report compiled by Terradata. Five maps showing mineral resource potential were prepared: nationally important industrial minerals, regionally important industrial minerals, metals, uranium, and saline minerals.

8. The geostatistical study in Phase II was similar to that in Phase I, but was more complete due to the availability of new data. The CDCA was geostatically classified as to the potential for gold, iron, manganese, tungsten, combined copper-lead-zinc-silver, and combined metal deposits (all of these metals combined). Results are presented in tabular form and in map form. The work was done under contract by Terradata.[2]

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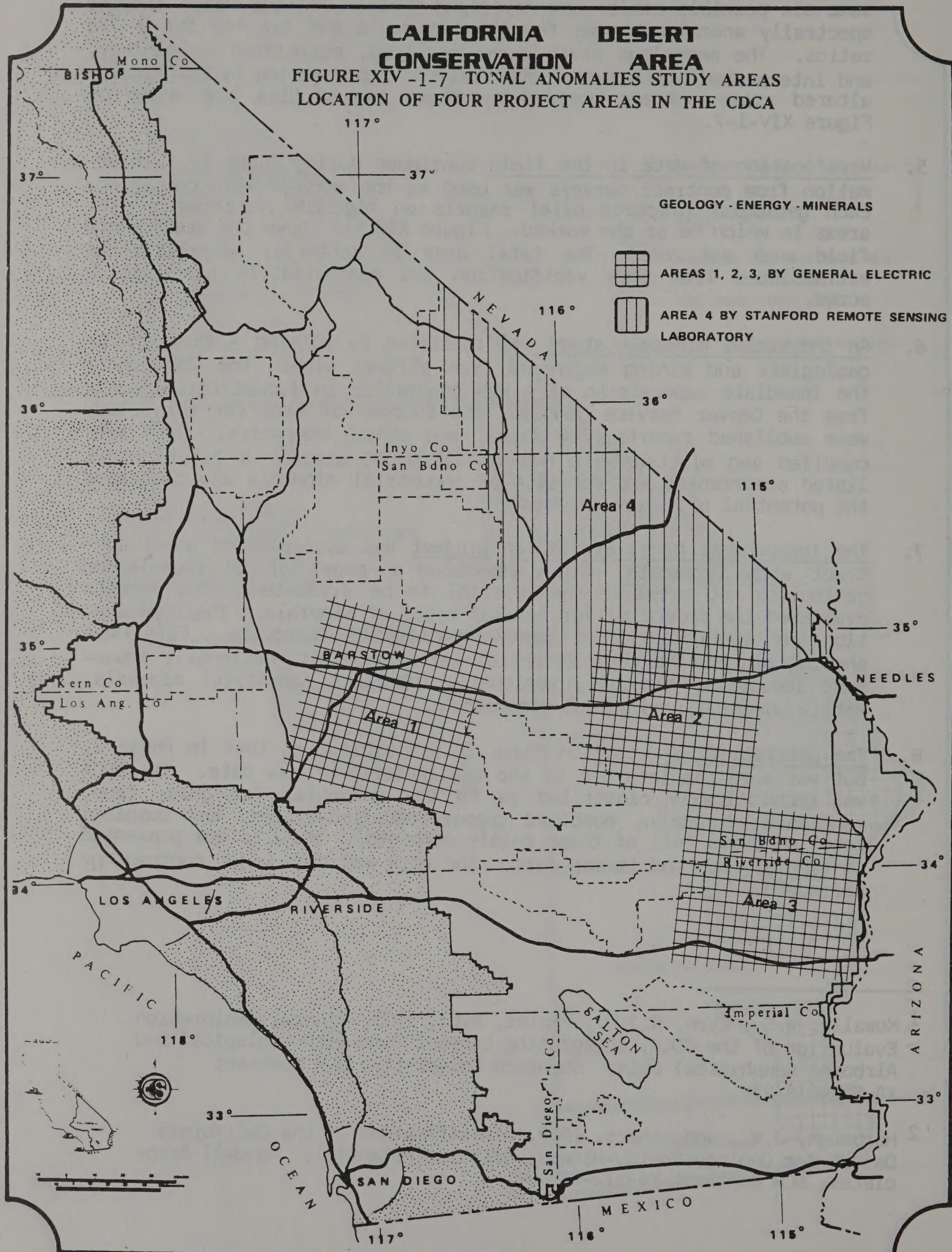
[1] Kowalik, W.S., Lyon, R.J.P., Prelat, A.E., 1979, Mineral Exploration Evaluation of the CDCA, Integrating Landsat Data with Geological and Airborne Geophysical Data: Stanford University, BLM Contract YA-512-CT8-234.

[2] Harbaugh, J.W., and others, 1979, Classification of the California Desert for Geology-Energy-Mineral Resource Potential: Kendall Associates, BLM Contract YA-512-CT9-66.


CALIFORNIA DESERT CONSERVATION AREA
FIGURE XIV -1-7 TONAL ANOMALIES STUDY AREAS
LOCATION OF FOUR PROJECT AREAS IN THE CDCA
GEOLOGY - ENERGY - MINERALS
AREAS 1, 2, 3, BY GENERAL ELECTRIC
AREA 4 BY STANFORD REMOTE SENSING LABORATORY
Mono Co
BISHOP
NEVADA
Inyo Co
San Bdno Co
Area 4
BARSTOW
Kern Co
Los Ang. Co
Area 1
Area 2
NEEDLES
San Bdno Co
Riverside Co
Area 3
LOS ANGELES
RIVERSIDE
PACIFIC
OCEAN
SALTON SEA
Imperial Co
San Diego Co
SAN DIEGO
MEXICO
ARIZONA
117°
37°
116°
36°
115°
35°
34°
118°
33°

9. The mineral economics study started after all other data were gathered from BLM studies and from contracts. A report of the results of this study is included in this Appendix.

ANALYSIS AND INTERPRETATION OF THE DATA BASE

The GRA Files

The CDCA was subdivided into 92 GEM Resource Areas (GRAs) on the basis of geologic environment and mineral or administrative units. Seventeen of the GRAs are in National Parks or areas managed by the military. The other 75 GRAs fall within the remainder of the CDCA. Figure XIV-1-8 shows the 75 GRAs, and names are given on Figure XIV-1-9.

After the GRAs were delineated, a file was created for each area; all pertinent data were extracted from the data base and placed in these files. The written material consists of copies of technical articles, lists of mineral occurrences, geochemical and geophysical data, descriptions of field-verified areas, descriptions of field-verified tonal anomalies, reclamation plans with the counties, BLM technical reports, copies of public comments, and other information pertinent to the respective GRA. Figure XIV-1-10 shows a form within each GRA file listing maps and overlays.

Analysis and Interpretation

With the data organized, analysis and interpretation began. The purposes of analyzing the GRAs were to provide information to BLM managers and others and to use these geological data to identify areas of potential mineralization. The locatable mineral commodities found in the CDCA were divided, as follows, to aid in the analysis:

Category I Commodities

Category I commodities (see Glossary, p. 199) include most of the strategic and energy related mineral resources (commodities of which the U.S. imports 50 percent or more and commodities of which the U.S. is a net exporter which also exist in significant quantities in the CDCA) and other mineral and/or energy resources of local, national, and/or regional importance and of which the CDCA is a source.

Copper	Tungsten	Kyanite	Gypsum
Gold	Uranium	Limestone/dolomite	Graphite
Iron	Vanadium	Mica	Fluorite
Lead	Zinc	Pyrophyllite	Calcium salts
Lithium	Asbestos	Strontium	Titanium
Manganese	Barite	Talc	Tin
Molybdenum	Borates	Wollastonite	Thorium
Rare Earths	Hectorite	Zeolites	Silver

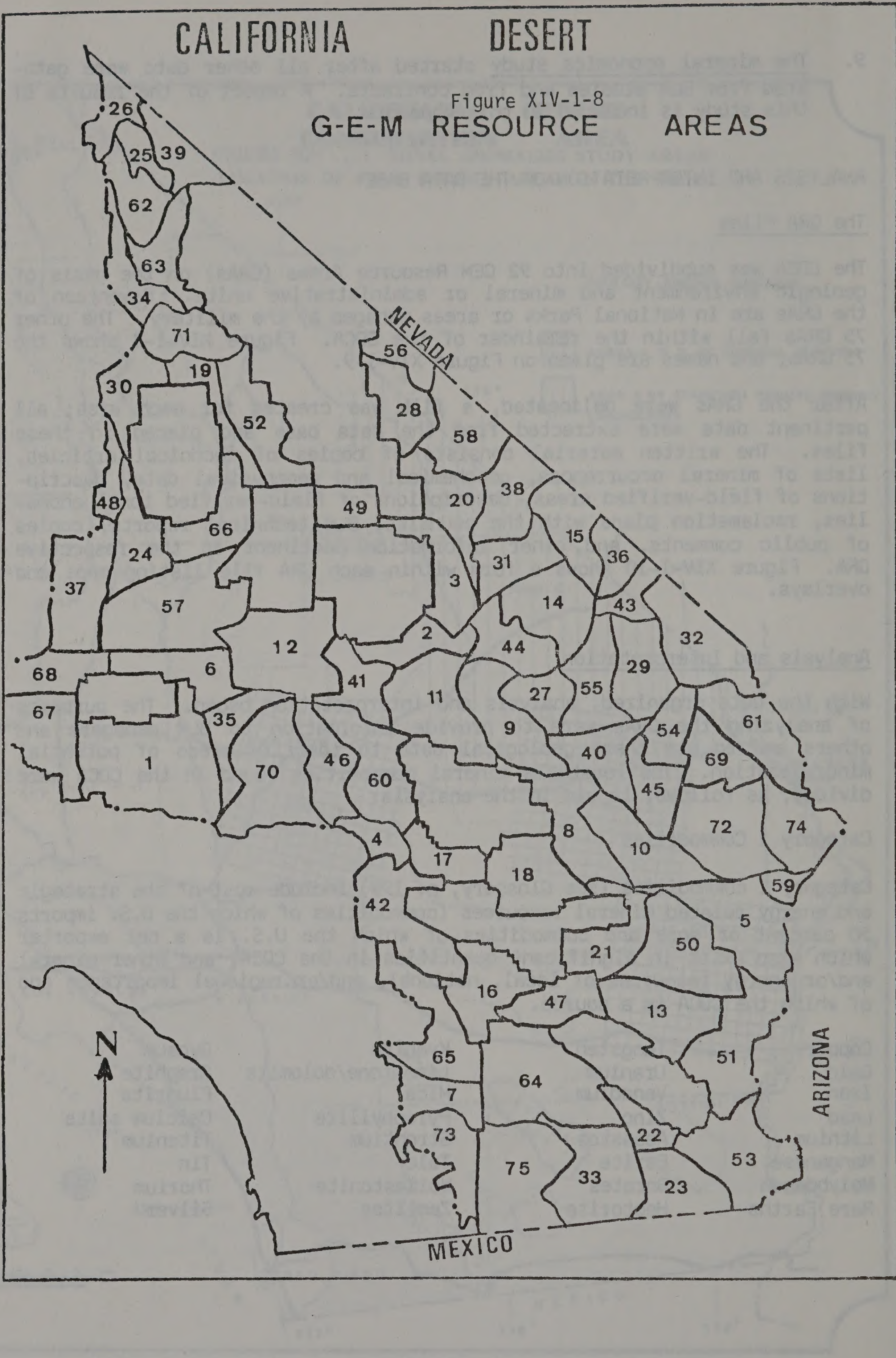

CALIFORNIA DESERT
Figure XIV-1-8
G-E-M RESOURCE AREAS
NEVADA
ARIZONA
MEXICO
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Figure XIV-1-9

LIST OF G-E-M RESOURCE AREAS

NO.	AREA	NO.	AREA	NO.	AREA
1.	Adobe Mountain	*26.	Fish Lake Valley	51.	Palo Verde Mountains
2.	Alvord Mountain	27.	Granite Mountains	*52.	Panamint
**3.	Avawatz Mountain	*28.	Greenwater Range	*53.	Picacho
4.	Bighorn Mountains	*29.	Hackberry	54.	Piute Mountains
*5.	Big Maria Mountains	30.	Haiwee Reservoir	55.	Providence Mountains
6.	Boron	*31.	Halloran	*56.	Pyramid Peak
7.	Borrego Springs	*32.	Homer Mountain	57.	Red Mountain
8.	Bristol Lake	33.	Imperial Valley	*58.	Resting Spring Range
*9.	Bristol Mountains	*34.	Inyo Mountains	*59.	Riverside Mountains
10.	Cadiz/Danby Lake	35.	Iron Mountain	*60.	Rodman Mountains
*11.	Cady Mountains	36.	Ivanpah Valley	61.	Sacramento Mountains
*12.	Calico Mountains	37.	Jawbone Canyon	*62.	Saline Range
*13.	Chuckwalla Mountains	*38.	Kingston Range	*63.	Saline Valley
14.	Cima Dome	*39.	Last Chance Range	64.	Salton Sea
*15.	Clark Mountain	40.	Marble Mountains	65.	Santa Rosa Mountains
16.	Coachella	41.	Mojave Valley	*66.	Searles
17.	Copper Mountain	**42.	Morongo Valley	67.	Sierra Pelona
**18.	Dale Lake	43.	New York Mountains	68.	Soledad/Rosamond
*19.	Darwin/Slate Range	*44.	Old Dad Mountain	69.	Stepladder Mountains
*20.	Dumont Dunes	45.	Old Woman Mountains	*70.	Stoddard
21.	Eagle Mountain	46.	Ord Mountain	*71.	Talc City Hills
22.	East Mesa-North	47.	Orocopia Mountains	72.	Turtle Mountains
23.	East Mesa-South	48.	Owens Peak	73.	Vallecito Mountains
24.	El Paso Mountains	*49.	Owlshead Mountains	*74.	Whipple Mountains
*25.	Eureka Valley	*50.	Palen/McCoy Mountains	75.	Yuha Basin

*Initial GRA analysis completed by November 1, 1980.

**Initial GRA analysis completed by August 1, 1981.

FIGURE XIV-1-10

Date ______________

MAPS AND OVERLAYS ________________________________ GEM RESOURCE AREA

Items marked X are not in this file. Circled numbers indicate maps and overlays most useful in interpreting potential.

NUMBER	TITLE	ADDITIONAL MAPS/OVERLAYS
1.	Topographic Base	
2.	Geologic Map	
3.	Land Nets	
4.	Field Verification	
5.	Known Occurrence	
	a. Metallics (Terradata)	
	b. Industrial Minerals	
6.	Geostatistics	
	a. Gold	
	b. Cu-Pb-Ag-Zn	
	c. Iron	
	d. Manganese	
	e. Tungsten	
	f. Combined Metals	
7.	Expert Panel Classification	
	a. Metals	
	b. Uranium	
	c. Ind. Mnrls. - National	
	d. Ind. Mnrls. - Reg., Loc.	
	e. Salines	
8.	Lineament Study	
	a. Lineaments	
	b. Metals Potential - Total Scores	
	c. Metals Potential - Components	
9.	Geochemistry	
	a. Sample Locations	
	b. One Sample - One St. Dev.	
	c. Two Samples - Two St. Dev.	
10.	Geophysics	
	a. Gamma-ray - Uranium	
	b. Gamma-ray - Thorium	
	c. Gamma-ray - K+	
	d. Magnetic Anomalies	
	e. Bouger Anomaly	
	f. Tonal Anomaly	
11.	Economics	
12.	Lands Status - Minerals	
	a. Segregation and Withdrawals	
	b. Wilderness Study Areas	

Figure XIV-1-10 (continued)

NUMBER	TITLE	ADDITIONAL MAPS/OVERLAYS
13.	Claims and Leases	
	a. Claims	
	b. Leases	
14.	Mineral Potential	
	a. Metals	
	b. Industrial Minerals (Loc.)	
	c. Uranium-Thorium	
	d. Geothermal	
	e. Oil and Gas	
	f. Sodium/Potassium	
	g. Salables	
15.	Leasables (USGS Classif.)	
	a. Sodium/Potassium	
	b. Oil and Gas	
	c. Geothermal	
16.	Salables	
17.	Paleontology	

Category II Commodities

Category II commodities (see Glossary, p. 199) include strategic and/or imported and/or nationally important minerals that occur in the CDCA but, so far, are not known in significant quanitities; other minerals that, although known in significant quantities in the CDCA, do not yet have enough demand; and commodities with a low unit value.

Antimony	Mercury	Nickel	Abrasives
Bentonite	Feldspar	Silica	Sulfur
Perlite	Magnesite	Gemstones (usually locatable)	

Note: Leasable and salable resources were classified slightly differently (Figure XIV-1-11).

A classification system (Figure-XIV 1-11) was designed to permit the delineation of areas with different GEM resource potential. This system was originally created for locatable minerals, but it was adapted for use with leasable (energy and non-energy) and salable resources.

In evaluating and classifying each GRA, the analyzed and interpreted data were used as direct or indirect evidence of potential mineralization. Although not always the same, the reported occurrences, geochemical anomalies, gamma-ray uranium and/or thorium anomalies, classification by USGS and/or CDMG, past and/or present production, and mineral economic data were used as direct evidence. Gamma-ray potassium anomalies, lineaments, Bouguer gravity anomalies, tonal anomalies, and others were most often considered as indirect evidence. However, combination, correlation, and coincidence may change the importance given to certain data. This was left to the professional judgment of the geology staff. Although there were often similarities, no two GRAs were alike. Similarly, information found to be useful in one GRA was less useful in another.

As evaluation proceeded, overlay maps were prepared for locatable metallic minerals; locatable nonmetallic minerals; uranium; thorium; leasable minerals including geothermal, oil and gas, sodium and/or potassium; and salable minerals. These maps, listed as Maps 14a through 14g on Figure XIV-1-10, show how the GRA was classified using the classification system described above. As each map was developed, a narrative rationale was prepared for each classified area. The rationale describes the evidence used and the significance. Other overlays, not listed in Figure XIV-1-10, were prepared at the discretion of the geologist.

Finally a report was written on the GRA, using the following format:

GEOLOGY-ENERGY-MINERALS RESOURCE AREA REPORT

I. Introduction

II. General Geology

A. Physiography
B. Rock Units
C. Detailed Lithology and Stratigraphy
D. Paleontology

Figure XIV-1-11
Mineral Potential Classification

CLASS	LOCATABLE	LEASABLE			SALABLE
		GEOTHERMAL	OIL & GAS	SODIUM/POTASSIUM	
1a	Present or intermittent producer or active development of any locatable mineral, and associated favorable geologic environment. Development means that an ore body has been defined, and work is continuing.	Present producer or development and associated geologic environment.	Same as Geothermal.	Same as Geothermal.	Present producer or development.
1b	Past producers and/or reserves of any category I minerals and associated favorable geologic environment.	KGRA - favorable for plant siting.	KGS - past producer and/or reserves.	Valuable for Na/K or K reserve, past producer and reserves.	(does not apply)
1c	Past producers and/or identified resources of any category I minerals and associated favorable geologic environment.	KGRA - less favorable for plant siting.	KGS - past producer and/or resources.	Valuable for Na/K or K reserve, past producer & resources.	(does not apply)
2a	Past producers and/or reserves of any category II minerals and associated favorable geologic environment. Does not apply to uranium.	PGRA - favorable for plant siting.	Prospectively Valuable: in Overthrust Belt, or has shows from wells.	Prospectively Valuable for Na and/or K, salines known present.	Reserves.
2b	Past Producers and/or identified resources of any category II minerals and associated favorable geologic environment. Does not apply to uranium.	PGRA - less favorable for plant siting.	Prospectively Valuable: other potentially favorable areas.	Prospectively Valuable for Na and/or K, salines not known to be present.	Past Producers
2c	Occurrences (nonproducers) or direct evidence for occurrence of any category I minerals and associated favorable geologic environment.	Direct evidence for geothermal energy, not in PGRA or KGRA.	Direct evidence for oil and/or gas, not classified by USGS.	Direct evidence for Na and/or K, not classified by USGS.	(does not apply)
3a	Occurrences (nonproducers) or direct evidence for occurrence of any category II minerals and associated favorable geologic environment.	(does not apply)	(does not apply)	(does not apply)	Favorable geologic environment, may be economic in foreseeable future.
3b	Favorable geologic environment for occurrence of any locatable mineral.	Favorable geologic environment based on indirect evidence, not in PGRA or KGRA.	Favorable geologic environment based on indirect evidence, not classified by USGS.	Same as oil & gas.	Favorable geologic environment, not economic in near future.
4a	Data insufficient to classify.	Same as locatables.	Same as locatables.	Same as locatables.	Same as locatables.
4b	Lithologies exposed at surface are unfavorable for locatable mineral occurrence.	Insufficient data, probably unfavorable.	Same as geothermal.	Same as geothermal.	Same as geothermal.
4c	Data insufficient to classify, but potentially favorable lithologies may be present.	Same as locatables.	Same as locatables.	Same as locatables.	Potentially favorable environment. Poor access. May be important in the future.

E. Structure and Tectonics
F. Historical Geology Synopsis

III. Mineral Resources

A. Known Mineral Deposits
B. Known Mineralized Areas, Occurrences, and Prospects
C. Mining Claims, Leases, and Material Sales Sites
D. Mineral Deposit Types

IV. Land Classification of GEM Resources Potential

A. Locatable Minerals

1. Metallic
2. Uranium/Thorium
3. Nonmetallic

B. Leasable Minerals

1. Oil and Gas
2. Geothermal
3. Sodium and Potassium
4. Other (If Any)

C. Salable Minerals

V. Recommendations for Additional Study

VI. References

The classification maps were combined from all of the GRAs into a two-piece (north and south half) 1:250,000 scale CDCA map. A simplified map consolidated the 11 classes into 5 for locatable minerals. Using the simplified classification, a new map was developed for each of the resource groups: locatables, leasables, salables, and energy. The description of the simplified classification is provided in the legend for the maps (attached to the plan), as well as in the Glossary (included in this appendix).

Since few areas were completely analyzed by the time the Draft Plan was sent to the public in February 1980, a CDCA-wide preliminary analysis and classification was completed for the Draft alternatives.

For the Proposed Plan, time allowed analysis and interpretation of 30 GRAs. The selection of the 30 GRAs was based on Wilderness Study Area ranking. The 32 GRAs analyzed prior to and the 3 GRAs analyzed subsequent to publication of the Final Desert Plan are identified in Figure XIV-1-9. For the remainder of the CDCA, the preliminary analysis and interpretation were used and so indicated on the maps presented in the plan. Analysis and interpretation of the other 41 GRAs are in progress. These 41 reports will be completed by 1983, if funds and personnel remain at the anticipated levels.

The Clark Mountain GRA (number 15, Figure XIV-1-8) report is presented on the following pages to acquaint the reader with our data.

EVALUATION OF THE CLARK MOUNTAIN G-E-M RESOURCE AREA

Introduction

The Clark Mountain GRA is located in eastern San Bernardino County on the eastern edge of the CDCA and covers 256,000 acres (1,036 square kilometers). It is in the Needles Resource Area and extends from Townships 13N to 19N and Ranges 11E to 14E, San Bernardino Base and Meridian. The northeastern border of the GRA is the Nevada state line. The area includes from north to south: Mesquite Mountains and Mesquite Valley, Clark Mountain Range, Mohawk Hill, Mescal Range, and Ivanpah Mountains. Adjacent GRAs include: Kingston Range, Halloran, Cima Dome, and Ivanpah Valley.

Interstate 15 cuts through the GRA in an east-west direction at Mountain Pass. Access to the area from the freeway is by Valley Wells, Mountain Pass, Nipton Road, Yates Well, and State Line off-ramps. The major secondary roads include Cima Road south and Excelsior Mine Road north from the Valley Wells Road. These two roads mark the western boundary of the GRA. Principal unpaved roads that lead into the upland areas are the Winters Pass Road, Mesquite Pass Road, State Line Pass Road, Cima-Ivanpah Valley Road, Piute Valley Road, and Kokoweef Road. Numerous mine roads provide access to most of the mines and prospected areas.

Mountain Pass is the only town within the GRA; services such as food, water, and gasoline are available to travelers. Baker is 35 miles west of Mountain Pass, and Las Vegas is about 50 miles to the northeast.

The principal sources of geologic information covering the GRA are Hewett (1956), Clary (1967), Dobbs (1961), Evans (1971), Olson et al. (1954), and others. The complete references to these and other works are appended to this report.

General Geology

Geologic Setting

The Clark Mountain GRA is composed of eight major distinct physiographic features: Mesquite Mountains, Clark Mountain, Northeastern Clark Mountain Range, Mohawk Hill, Mescal Range, Striped Mountain, Ivanpah Mountains, and Mesquite Valley. The various ranges, taken as a composite, form a northwest-trending upland area, which is bounded by the Mesquite, Shadow, and Ivanpah valleys. Clark Mountain (7,929 feet or 2,417 meters) dominates the physiography of the area and is visible for many miles as the major topographic feature.

There are two main drainage patterns in the area. On Clark Mountain the pattern is a slightly modified radial, with individual drainages being very steep, sharply defined, and relatively straight. Such features characterize a juvenile drainage pattern. The remainder of the upland area of the GRA has essentially a linear to rectilinear pattern with local dendritic modifications. In general, the hills and drainages are less steep and the topography noticeably more rounded than at Clark Mountain.

The pattern is somewhat more mature and reflects the locally dominant structural grain of the ranges in many areas. The structure of the area is further discussed below.

General Lithologic Overview

The Clark Mountain GRA is a complex lithologic area, with lithologic units ranging from granites and gneisses to unconsolidated sediments. The age of the units span the geologic time scale from the middle Precambrian to the Recent.

The Precambrian is represented by granitic gneisses, granites, and alkalic intrusives. The gneisses and granites are exposed in the northern, east-central, and southern portions of the GRA. The alkalic intrusives are located in the east-central portion of the GRA, in the vicinity of Mountain Pass.

The Paleozoic section contains units from the Cambrian through the Permian (Figure XIV-1-12) and can be divided into two major lithologic sequences (Dibblee 1980). A basal, mostly clastic, sequence of late Precambrian through middle Cambrian rocks is exposed along the western portion of the GRA. Hewett (1956) further divided this clastic sequence into an eastern and western facies based on their depositional characteristics. The upper sequence ranges from the Late Cambrian through the Permian and is essentially a sequence of marine carbonate units. These units trend northwards through the center of the GRA.

The Mesozoic section contains two major lithologic subdivisions in the GRA. A basal shallow marine and continental clastic sequence is present as scattered remnants in the northeastern portion of the GRA. These are of lower Triassic age. The remainder of the Mesozoic Era, from the Middle Jurassic through the Cretaceous, was a period of igneous activity. There are dacite flows and breccias of Middle Jurassic age exposed in the south-central portion of the GRA, and most of the southern portion of the GRA is underlain by quartz monzonites of Cretaceous and Early Tertiary ages (Hewett 1956). The Tertiary section is represented by various clastic units of continental origin. These are present throughout the GRA.

Detailed Lithologic Descriptions

Precambrian Rocks. The following lithologic descriptions are summarized from Dibblee (1980) and Hewett (1956). The Lower(?) and Middle Precambrian gneisses and schists exposed in the Clark Mountain GRA were probably of sedimentary and volcanic origin, based on the occurrence of garnets, sillimanite, andalusite, and biotite in the schists and large lenses and layers of amphibolite in the gneisses. These units have been intruded and injected by granulites and alaskites of middle(?) to late Precambrian age.

In the vicinity of Mountain Pass a zone of late Precambrian alkalic intrusives, composed of syenites, shonkinites, and carbonatites, intrude the older gneisses and schists described above. The carbonatites contain rare earth elements, barium thorium, and strontium. The largest carbonatite

Figure XIV-1-12

RELATIVE GEOLOGIC TIME

ERA	PERIOD	EPOCH	Millions of Years Before Present
Cenozoic	Quaternary	Holocene	0.011
		Pleistocene	1.5 - 2
	Tertiary	Pliocene	5 - 7
		Miocene	23 - 26
		Oligocene	37 - 38
		Eocene	53 - 54
		Paleocene	65
Mesozoic	Cretaceous		136
	Jurassic		190 - 195
	Triassic		225
Paleozoic	Permian		280
	Pennsylvanian		320
	Mississippian		345
	Devonian		395
	Silurian		430 - 440
	Ordovician		500
	Cambrian		570
Precambrian	Late		$\sim$1,000
	Early		4,500

body at Mountain Pass is host to the world's largest rare earths mine, which is owned and operated by Molycorp, Inc., a subsidiary of Union Oil Company of California. The carbonatites have been intruded as northwest-trending sill in the Precambrian gneisses. A total of eight plugs of alkalic composition, including the carbonatites, form this sill. They range from 400 feet to 6,300 feet in length and dip to the south at 50°. Further details may be found in Woyski (1980).

Paleozoic Rocks

Cambrian. The Cambrian section is represented by six units, of which one is time transgressive from the Cambrian into the Devonian.

The Noonday Dolomite, which is part of the western Cambrian facies defined by Hewett (1956), forms the basal Cambrian section. This unit is a pale cream, dolomite and varies in thickness from 125 to 2,000 feet. It rests unconformably upon the various Precambrian lithologies present in the area (Hewett 1956). It does not appear to be present east of the Mesquite Thrust Fault (Hewett 1956).

The Prospect Mountain Quartzite consists of several lithologic units of different composition. At the base is a red, shaly sandstone, which is overlain by a thin, grey dolomite. The succeeding bed is a fine-grained quartzite containing pebble beds, in turn overlain by oolitic dolomite. The uppermost bed is a thin-bedded, fine-grained quartzite. Total thickness of the formation varies from 1,500 to 4,000 feet in the study area. Further details may be found in Hewett (1956).

The eastern facies of the Prospect Mountain Quartzite is represented by a small exposure of the Tapeats Sandstone at Mesquite Pass. The Tapeats is the lateral equivalent of the Prospect Mountain Quartzite. At this locality, the unit consists of 400 feet of reddish quartzite lying unconformably on Precambrian gneisses (Hewett 1956). Another small exposure is present about 1,000 feet southwest of the Colosseum Mine and is about 200 feet thick.

The Pioche Shale is extensively exposed in the study area. It consists of about 1,000 feet of green shale that overlies the Prospect Mountain Quartzite. The shale has small units of carbonate rocks and sandstone within it.

The eastern facies of the Pioche Shale, the Bright Angel Shale (Hewett 1956), is exposed in a small area in the Mesquite Pass. Here, it is about 150 feet thick and is composed of reddish-brown quartzite and green shale units.

Cambrian-Devonian. The Goodsprings Dolomite is widespread throughout the study area and is commonly fault-bounded on its basal surface. The formation is a thick-bedded, blue-grey dolomite with occasional thin shale beds in the basal portions and occasional thin sandstone units in its upper portions. The unfolded thickness of the Goodsprings Dolomite is about 2,500 feet. Various fossils collected from the formation are of Late Cambrian, Early Ordovician, Silurian, and Devonian ages (Hewett 1956).

Devonian. The Sultan Limestone is present as a belt trending north-south down the central portion of the study area. The formation is a grey to buff colored limestone, locally altered to dolomite, and is about 600 feet thick. Fossils found in the formation suggest a Middle Devonian age for most of the unit. The upper third may be of Mississippian age (Hewett 1956).

Mississippian. The areal extent of the Monte Cristo Limestone is the same as the underlying Sultan Limestone. The Monte Cristo Limestone is blue-grey to dark grey in color and ranges from 350 to 700 feet thick in the study area. Dolomite beds are locally common. Faunal assemblages collected from this unit have yielded Early Mississippian ages (Hewett 1956).

Pennsylvanian. The Pennsylvanian System is represented by two formations, the lower carbonate Bird Springs Formation and the overlying clastic Supai Formation. The Bird Springs Formation lies unconformably upon the Monte Cristo Limestone. The Bird Springs consists of a light to smokey-grey dolomite with occasional beds of sandstone and chert. Its average thickness is 500 feet.

The Supai Formation is probably time transgressive and extends into the Permian in this area. This formation, in the Mesquite Mountains, consists of 1,150 feet of red shale and sandstone with local beds of gypsum.

Permian. The Kaibab Limestone outcrops in association with the underlying Mississippian and Pennsylvanian formations in the area. The unit consists of 400 feet of grey limestone with minor beds of chert, dolomite, and sandstone. Fossils are common in its upper portions. This unit is used as a marker horizon in the study area for structural interpretations. Paleozoic rocks in this area host hydrothermal lead-zinc-copper mineralization.

Mesozoic Rocks

Triassic. The Moenkopi Formation is exposed in the Mesquite Mountains. Here, it consists of 400 to 500 feet of red and grey shale, sandstone, and a basal conglomerate. A small buff-colored limestone bed extends through the middle of the formation. Faunal assemblages have established a lower Triassic age for this unit (Hewett 1956).

The Chinle Formation is exposed two miles northwest of Kokoweef Peak and is about 800 feet thick. Here it consists of red, brown, and green shales and sandstones.

Jurassic. The Aztec Sandstone overlies the Chinle Formation at the above location and it is 800 feet thick. Marzolf (1980) has correlated the Aztec Sandstone with the Navajo Sandstone of the Colorado Plateau region. In the study area, it has a minimum thickness of 500 feet. It is a red, cross-bedded sandstone of probable eolian deposition.

In the vicinity of the Mollusk Mine is an extensive outcrop of andesites and quartz latites that have been assigned to the Delfonte Volcanics by Marzlof (1980). These flows and volcaniclastics have been dated as Jurassic in age by Carr (1977).

Cretaceous. The Cretaceous here was a time of igneous intrusive activity. The batholith known as the Teutonia quartz monzonite was created at this time. Most of the metallic mineral deposits in this area resulted from hydrothermal fluids related to this intrusion.

Cenozoic Rocks

Tertiary and Quaternary. The Tertiary Period in the study area was a period of major orogeny and deformation. The intrusion of the Teutonia quartz monzonite continued into the early Tertiary. Uplift and erosion have created numerous clastic units now covered by Recent alluvium.

Paleontology

Fossil invertebrates are reported (Murphy 1978) to occur at three localities in the northeastern Clark Mountains and at one locality each in the southern Mesquite Range, the Mescal Range, and at Striped Mountain. The fossil types include corals, brachiopods, "bivalves" (assumed to be pelecypods), gastropods, and bryozoa.

The potential for fossil vertebrate localities is considered by Woodburne (1978) to be high at the Shadow Valley playa (Valley Wells), in the southeastern part of the Mescal Range, and at two localities in the Ivanpah Mountains. Moderate potential for sites occurs at the Mesquite playa, and all of the older Quaternary alluvium is considered low potential.

A dinosaur trackway site at the southeastern Mescal Range is adjacent to a dimension stone quarry. In 1980 this site was proposed as an Area of Critical Environmental Concern to protect the valuable paleontologic resources. The other areas of paleontologic resources are relatively protected by their remote locations, the lack of publicity about the sites, and, in some cases, the ruggedness of the topography. Should public interest in collection (or vandalism) at these sites increase dramatically, some management action may be needed to protect the more significant of these resources.

Structure and Tectonics

The structural history of this GRA is very complex and poorly understood, although progress has been made in recent years. Of primary importance are the large-scale normal and thrust faults. Hewett (1956), Clary (1967), Evans (1971), and Olson et al. (1954) have mapped and/or discussed many structural features of the region; however, the field guide by Burchfiel and Davis (1971a) is currently the definitive work on the configuration of the thrusts.

Burchfiel and Davis describe a thrust complex composed of three major plates which have a minimum total displacement of 40 to 50 miles to the east and northeast. These plates are (from the lowest and eastern-most to the highest): Keystone, Mesquite Pass, and Winters Pass. Motion on these faults has been determined to have occurred during the following periods.

The Mesquite Pass basal thrust is greater than or equal to 190 to 200 million years before present (m.y.b.p.), the Winters Pass thrust is no younger than 92 m.y.b.p., and the Keystone thrust is dated at 85 to 94 m.y.b.p.

The Keystone and Mesquite Pass plates are primarily composed of Paleozoic marine sedimentary units. The Winters Pass plate is composed dominantly of Cambrian and Precambrian sedimentary and metamorphic rocks.

Evans (1971) also maps, without discussion, several thrusts in the Mescal Range-Striped Mountain area. Unfortunately, his nomenclature and mapped positions do not correspond with those of Burchfiel and Davis, making direct correlation difficult. In both mappings, the internal structural detail of the thrust plates has been simplified and/or eliminated. Each of the major thrust plates may, in fact, be composed of a series of several imbricate thrusts of lesser extent or magnitude. Burchfiel and Davis show some of these faults--those sufficiently important to warrant naming on their 1:62,500 scale sketch map.

Recent work (Sharp 1980) indicates that in the vicinity of the Colosseum Mine, localized gravity sliding may have occurred on the Keystone dêcollement after the cessation of thrusting. The east-to-west sliding is interpreted to have occurred in response to local structural doming that resulted from the intrusion of a felsite breccia pipe complex at the Colosseum Mine.

The principal normal faults exposed in the area are the Ivanpah, Clark Mountain, and State Line faults. Although each of these faults is a major structural feature, little is said in the literature regarding their offsets. Clary (1967) indicates 10,000 feet of displacement on the Ivanpah Fault, and Hewett (1956) shows a value of 18,000 feet on the Ivanpah at a location where the gravity data suggest little density contrast. If the fault displacements are true, the material east of the fault in northern Ivanpah Valley must not have much alluvium covering Precambrian terrane below. Hewett shows the Ivanpah Fault dying out (down to 1,500 feet offset) in the New York Mountains south of the Ivanpah Valley.

North of the Clark Mountains, the Ivanpah Fault is not mapped; however, physiographic and structural studies of the Mesquite Mountains and Mesquite Valley strongly suggest several thousand feet of normal faulting along a northward projection of the Ivanpah Fault. The development of this valley probably was a recent event (Late Cenozoic) and, as such, probably is not related to the tectonic regime which created the Ivanpah Fault. However, the localization of the western boundary of Mesquite Valley may have resulted from the presence of this preexisting zone of weakness.

Hewett (1956) suggests that the west side of the State Line Fault has dropped 1,200 feet. Two other unnamed faults located between the State Line and Ivanpah faults are shown by Hewett to have 1,200 and 3,000 feet of throw. The first unnamed fault is a minor thrust with the thrust plane dipping west, and the second fault is a west-dipping normal fault (down to the west). Both of these faults occur in the northeastern arm of the Clark Mountain Range.

The Clark Mountain Fault (probably the same structure as the Kokoweef Fault of Burchfiel and Davis), a southeast-trending normal fault, cuts across the Ivanpah Mountains from a point about 2 miles southwest of Mountain Pass to

Ivanpah Valley. This feature forms the southwestern outcrop boundary of the early Precambrian terrane in the Ivanpah Mountains, and the vertical offset of several thousand feet is upthrown on the northeast side. As shown on the California Division of Mines and Geology (CDMG) Kingman map sheet, the fault is projected across Ivanpah Valley to and across the New York Mountains. The surface trace geometry is sinuous and rather extraordinary for a simple normal fault. It appears probable that if the Clark Mountain Fault does cut across Ivanpah Valley, it has been deformed or cut by a buried northeast-trending structure, with a net left-lateral offset on the order of two to three miles.

Gravity data for the region suggest the existence of a buried, north-south-trending normal fault on the west side of northeastern Ivanpah Valley. This inferred fault trends south from the junction of the Nevada state line and the I-15 freeway. A vertical offset of a few thousand feet is suggested by the anomaly. None of the major normal faults appear to have played a significant role in the localization of identified ore deposits.

Geologic Evolution

The geologic evolution of the study area has been summarized by Dibblee (1980) and Hewett (1956) and will only be briefly outlined here, with the emphasis on ore forming environments. The Precambrian rocks in the study area indicate the existence of a portion of a greenstone belt and associated sedimentary basin as evidenced by the schists and amphibolites in the area. A deformational and intrusive event in the Precambrian is recorded by the presence of the gneisses and granite of Precambrian age.

The emplacement of the alkalic plugs and sills, including the carbonatite, is indicative of a special tectonic setting. This setting is a regional fault controlled zone, usually a zone of rifting, that forms in and under a stable craton (Stanton 1972). Associated with these intrusives are normally a suite of alkalic and phonolitic intrusive and extrusive rocks. In other parts of the earth carbonatites often occur in restricted areas as multiple intrusions. Although only one carbonatite body has been mapped in this area, other bodies may not be exposed on the surface.

The Paleozoic was a period of fairly continuous deposition in the study area. The basal Cambrian dolomites and quartzites were deposited on an eroded Precambrian surface of some relief. The depositional environment, which existed through the Pennsylvanian, was a shallow to moderate depth basin. High energy features do not appear to be common in the stratigraphic record. The end of the Pennsylvanian is characterized by the initiation of clastic deposition in the area (the Supai Formation) but this was soon replaced by more carbonate deposition and quieter conditions as evidenced by the Kaibab Limestone.

The Mesozoic was a time of uplift, erosion, and tectonic instability in this area. The clastic debris of the Moenkopi and Chinle Formations was laid down in a shoreline and fluviatile environment. These were then overlain by the eolian sands of the Aztec Sandstone. In the Middle Jurassic, volcanism became dominant in this area and the Delfonte Volcanics were extruded. During the Cretaceous, the emplacement of the large batholith (Teutonia quartz monzonite) was initiated. This intrusive activity continued into the early Tertiary.

Large-scale thrust faulting began in the latest Triassic or Early Jurassic time and continued into the early Tertiary. By mid-Tertiary time the tectonic stress fields changed, and the block faulting that characterizes the Basin and Range began. This block faulting continues to the present.

Mineral Resources

This GRA may be the most mineralized area of its size in the CDCA. The potential for future discoveries and/or reactivation of old workings is extraordinarily high. The area has well over 60 mines or mining districts and the workings and prospects number in the hundreds. Occurrence of metallic commodities (Au, Ag, Pb, Zn, Cu, W, Sn, Sb, rare earth elements), energy materials (U, Th), nonmetallic minerals (fluorite, gypsum, barite, magnesite, strontianite, limestone, dolomite, silica), gemstones (azurite, malachite), and salable materials (dimension stone, slate, sand, and gravel) has been recorded. The potential for renewed extraction of these and other commodities such as evaporites (sodium, potassium, and lithium) and oil and gas is considered highly favorable. The rare earth elements (REE) have been included with the metals in the following analysis.

Estimates of the value of production plus potential production (as referenced in Table XIV-1-1) have been made for the following materials in the GRA: rare earth elements, thorium, limestone-dolomite, gypsum, gold, copper, silver, tin, tungsten, zinc, strontium, barite, lead, sand, and gravel. Estimated value of past production (in 1979 dollars) is over $500 million. The total estimated value of reserves and resources exceeds $8.6 billion (in 1979 dollars). Based on the analysis commencing on page 49, there is excellent potential for the discovery of new deposits, which would increase the mineral wealth.

Also, several mines are currently operating. The Mountain Pass rare earth deposit is the major operation in the GRA. The production from this mine supplies about 97 percent of the domestic demand for rare earth elements; it is the world's largest producer of these metals. The Morning Star Mine was reactivated for gold extraction in 1978. The Copper World is being worked intermittently for semiprecious, gem-quality azurite and malachite. Recent exploration of the Colosseum and Shire properties shows extensive reserves. There is renewed interest and exploration in the Old Ivanpah District and at the Carbonate King, Benson, and Umberci mines.

Known Mineral Deposits

Table XIV-1-1 shows the known mineral deposits in the Clark Mountain GRA.

Known Mineralized Areas, Occurrences, and Prospects

Table XIV-1-2 lists the known mineralized areas, occurrences, and prospects in the Clark Mountain GRA.

Mining Claims, Leases, and Material Sales Sites

Tables XIV-1-3 through XIV-1-6 indicate the patented mining claims, unpatented mining claims, oil and gas leases, and material sales sites in the Clark Mountain GRA.

Table XIV-1-1 Known Mineral Deposits

TOWNSHIP	RANGE	SECTION	PROPERTY	REMARKS
17N	11E	14,15	Glory (Foster)	Copper contained in parallel veins in porphyry and schist (Hewett 1956).
17N	12E	23?	Mammoth Mine (McCuen)	Production (1916-18). Ore: 100 short tons of ore yielding 22 to 25% Cu. Production (1919-29). Ore: 38 short tons of ore yielding 16 to 28% Cu. Ore minerals on the dump include, malachite, azurite, chrysocolla, auricalcite, and alunite. (Hewett 1956)
14N	13E	11	Teutonia Mine (Dutch Silver)	Production. Ore: 112 tons containing 100 to 150 ounces Ag/ton and several percent Pb (Hewett 1956).
15N	13E	25	Evening Star Mine	Production (1942). Ore: 25 tons, Sn 3,200 pounds. Ore located in a serpentine and calcite pod and consisted of magnetite and cassiterite. This appears to be a skarn deposit in a limestone with a well developed mineral zonation (Hewett 1956).
16N	13E	5	Dewey Mine	Production. Ore: 330 tons of Cu ore. Contact mineralization with tin in dolomite intruded by fine grained monzonite sills. Skarn zonation is well developed (Hewett 1956).
16N	13E	6	Copper World	Past production. Ore: Pb 1,000,000 pounds, Ag 60,778 ounces, Au 323 ounces, Cu 5,321,184 pounds. Production (1899-1900, 1906-08, 1916-18, and 1944). Grade of this ore averaged 6.75% Cu, 10% Pb, 5.8 oz./ton. Ag, and trace of Au. Mineralization is a 4-8 foot wide vein striking/dipping N40°W/50°SW along a limestone/porphyry contact. (Hewett 1956; Goodwin 1957; *Engineering and Mining Journal*, June 2, 1900, p. 657).
16N	13E	7, 8, 17, 18	Mohawk	Past production. Ore: Cu 203,456 pounds, Pb 3,125,105 pounds, Zn 1,094,800 pounds, Ag 92,772 ounces, Au 420 ounces. Production intermittent (1918-52). Grade of the ore was 12% Pb, 4.92 oz./ton Ag, 0.5% Cu, and minor Au. The mineralization is localized in a series of fissures paralleling a limestone/granite contact. The zone is 20 to 30 feet wide and contains

Table XIV-1-1 Known Mineral Deposits (continued)

TOWNSHIP	RANGE	SECTION	PROPERTY	REMARKS
				partially oxidized galena, sphalerite, and chalcopyrite with oxides of iron and manganese in the gangue (Goodwin 1957 and Hewett 1956).
16N	13E	8, 17	Yucca Queen	Past production (1926). Ore shipped assayed 25% Pb, 7.90 oz./ton Ag, minor Cu and Au. Past production (1942). Ore shipped assayed 2.6% Pb, 3.34% Cu, 17.30 oz./ton Ag, and some Au. Ore is localized in a fissure parallel to a limestone/diorite porphyry contact, the limestone ore minerals are cerussite, argentiferous galena, and chalcopyrite (Goodwin 1957).
16N	13E	12?	GA Fayle (Fayle)	Production (1917-18). Ore: 1100 tons assayed grade was 15.20% Pb, 3.06% Cu, 8.53 oz/ton Au. Mineralization is contained in a chlorite shear parallel to bedding, striking NW and dipping SW (Wright 1953 and Goodwin 1957).
16N	13E	12,13	Molycorp	Production (1954-1980). REO: 250,000 tons Reserves (1981): Ore: 44,000,000 tons, REO: 3,379,200 tons, (@ 7.68%), Thorium: 302,400 lbs. Resources: Strontium: 4,400,000 tons (@ 10%), Barite: 11,000,000 tons (@ 25%), Thorium: 300,000 lbs. The ore is contained in a late Precambrian carbonatite sill, which is 2300 x 200 feet in surface exposure, and dips 40 degrees to the west. The ore mineral is bastnaesite (average grade 12%). Daily production (1978) was 1800 tpd from the open pit. (Staatz et al. 1979, Brobst 1958, Warhol 1980, Union Oil 1980.)
16N	13E	13	Sulphide Queen	Production (1941): Ore: 6819 tons, Au 512 ounces, Ag 50 ounces. The vein is fine-grained quartz contained in gneissic granite. The sulphide minerals average several percent and consist of pyrite galena, and arsenopyrite. There is no free Au in the ore (Hewett 1956).

Table XIV-1-1 Known Mineral Deposits (continued)

TOWNSHIP	RANGE	SECTION	PROPERTY	REMARKS
16N	13E	24	Mescal Mine (Mollusk, Cambria)	Production (1908-15): Ore: 24 tons, Au 3.5 ounces, Ag 2369 ounces, 1880's production grade was 0.1 oz. Au/ton; 100 oz. Ag/ton. Ore is confined to replacement shoots in dolomite. Fine-grained quartz contained disseminated sulfide. Stibnite locally reaches 10 to 20 weight percent of the ore (Hewett 1956).
16N	13E	25	Blue Buzzard Mine	Production (1925-48). Ore: 143 tons, Au: 0.47 ounces, Ag: 304 ounces, Cu: 861 pounds, Pb: 64,254 pounds. Two small ore lenses were explored, containing plumbojarosite and iron oxides in limestone located 150 above its contact with the Teutonia quartz monzonite (Goodwin 1957).
16N	13E	29,30	Wilshire	Active (1948-52). Ore: Shipped in 1948-49, Assayed 1.67% Zn, 12.1% Pb, 0.3% Cu, 3.26 oz./ton Ag, and some Au; ore shipped in 1952 assayed 9.76% Pb, 2.57 oz/ton Ag, 0.22% Cu (Hewett 1956).
16N	13E	36	Iron Horse (Jack Rabbit)	Reported to contain Pb-Ag with Au (Hewett 1956).
17N	13E	8	Beatrice Mine	Production (1870-1880). Reported to have shipped bullion valued at $3,500,000 (1890). Recent assays range from 120 to 180 ounces/ton Ag. Vein in dolomite, films of copper and vanadium minerals common (Hewett 1956, U.S. Mineral Survey B-17).
17N	13E	9	Alley and Lizzie Bullock Mines	Production (1890). Ore: Ag content ranged from 300 to 4400 ounces per ton. Production (1946). A 37 ton shipment averaged 0.37 ounces per ton Au, 101 ounces/ton Ag, and 0.6% Cu. The veins are in dolomite and contain copper carbonate and stromeyerite in breccias (Hewett 1956).
17N	13E	9, 10	Jackson (Stonewall)	Active (1881-96), (1927-28), and (1938-42). The property is predominantly an Ag property with values. Ag assays are reported to range from 500 to 750 ounces/ton. Pb and Au reported (Hewett 1956 and Eric 1948).

Table XIV-1-1 Known Mineral Deposits (continued)

TOWNSHIP	RANGE	SECTION	PROPERTY	REMARKS
17N	13E	9	Snowstorm	Active (1880s). Ore: Ag content reportedly averaged 300 ounces per ton (Crossman 1890).
17N	13E	10	Green, Turner and Mallot Mine	Production. 6 tons of quartz yielding $720 Mine of Au (at $35/oz) Veins are in granite gneiss. Ore minerals pyrite and galena, plus oxidized equivalents (Hewett 1956).
17N	13E	10	Colosseum	Reserves (1978). 20 million short tons grading 0.07 oz/ton Au. Production (1929-39). Ore: 3,016 tons, Au: 624.42 ounces, Ag: 155 ounces, Cu: 285 pounds, Pb: 488 pounds. Mineralization is Cu-Au with Ag-Pb. Host rock is a breccia pipe developed in rhyolite plug (Tucker and Sampson 1943, Owens 1978, Hewett 1956).
17N	13E	15	Mojave Tungsten (Green)	Production (1915-16). 64,000 pounds of 60% WO_3 concentrate. Mineralization is scheelite and wolframite in quartz-calcite veins grading 0.5 to 5.0% WO_3 (Hewett 1956).
17N	13E	27	Clark Mt. Mine	Production. Known but not recorded. Breccia zone contains hydrozincite pods in limestone of the Bird Spring Formation (Hewett 1956).
17N	13E	30(?)	Green Gold (Bank Roll Valentine Kieper)	Production (1926-27). Ore: 42 short tons, Au: 1.09 ounces, Ag: 174 ounces, Cu: 74 pounds, Pb: 24,038 pounds. Production of Au-Ag-Cu recorded in 1939. Mineralization is in quartz veins along a quartz monzonite/limestone/shale contact. Ore minerals are galena, sphalerite, and chalcopyrite (Goodwin 1957, Hewett 1956).
17N	13E	31	Emperor (Vulture)	Production. Oxidized ore shipped in 1915-19. Assayed 0.71% Zn, 1.45% Pb, 3.6% Cu, 2.04 oz./ton Ag and minor Au. Complex ore is located along a granite limestone contact (Goodwin 1957, Eric 1948).
18N	13E	11	Calarivada	Copper vein in fractured bedding plane of a limestone unit (Hewett 1956).

Table XIV-1-1 Known Mineral Deposits (continued)

TOWNSHIP	RANGE	SECTION	PROPERTY	REMARKS
15N	14E	4	Crystal Cones	Reported to contain Zn and Cu (Goodwin 1957).
15N	14E	4	Revenue Copper	Production (1917-19). Ore: Four cars of ore shipped containing 25% Cu and $7 Au per ton. Mineralization is oxides and carbonates of copper with bornite and chalcopyrite along a limestone/porphyry contact (Jenkins 1948).
15N	14E	4	Piute Mine	Production (1915-17). Ore: 1,245 tons, Pb: 373,500 pounds, Cu: some, Zn: some, Ore minerals are galena, plumbojarosite and probably sphalerite and chalcopyrite. Mineralization localized in limestone near a quartz monzonite contact (Hewett 1956).
15N	14E	4, 9	New Trail	Active (1917-18, 1930-39). Production (1929-50). Ore: 1,173 short tons, Cu: 148,770 pounds, Au: 199 ounces, Ag: 6,824 ounces, Tactite zone with high grade bornite and chalcopyrite. Also reports Au and Ag values (Hewett 1956).
15N	14E	14	Ivanpah Mammoth	Cu-Ag-Au are reported from veins (Eric 1948).
15N	14E	18	Standard #1 Standard #2	Production (1906-19). Ore: 4,009 short tons, Au: 210 ounces Ag: 19,353 ounces, Cu: 690,279 pounds, Pb: 1,545 pounds, Ore minerals are copper carbonates and silicates. Reportedly leased in 1968 (Hewett 1956).
15N	14E	22	Allured Mine	Cu-Au in veins near limestone-quartz monzonite contact. Under consideration in 1979 for a heap leaching operation for Au (Hewett 1956).
15N	14E	25	Copper King	Active prior to 1910. Production (1909). Ore: 8 short tons, Cu: 2,080 pounds, Ag: 120 ounces, Au: 1 ounce. Reported tactite zone at granite/limestone contact, contains scheelite, cassiterite, and Au (Hewett 1956).

Table XIV-1-1 Known Mineral Deposits (continued)

TOWNSHIP	RANGE	SECTION	PROPERTY	REMARKS
15N	14E	28	Morning Star	Reserves 1953. 500,000 short tons grading 0.2 to 0.3 oz./ton Au. Currently operating through Vanderbilt Gold Mines (Wright et al. 1953 and Vanderbilt Gold Corporation 1979).
16N	14E	6	Carbonate King	Production (1941-51). Ore: 9,560 short tons, Au: 17 ounces, Ag: 58,541 ounces, Pb: 174,600 pounds, Zn: 5,534,213 pounds. Mineralization consists of calamine, smithsonite, and hydrozincite in brecciated limestone. Ore was in two tabular bodies, one of 4,300 tons, the other of at least 4,750 tons (Hewett 1956).
17N 18N	14E 14E	5 31	Carbonate King (Dewitt)	Production (1917-28). Ore: 719 short tons, Ag: 88,426 ounces, Cu: 1,409 pounds, Pb: 62,282 pounds, Zn: 2,824 pounds, Mineralization was galena, sphalerite and the oxidized products of them, and is confined to a breccia zone in limestone (Hewett 1956).
16N	14E	19	Wade Mine	Production (1926). Ore: 15 tons (on dump), Sb: 13,500 pounds (on dump). Quartz-barite veins in schistose granite host the mineralization (Hewett 1956).
17N	14E	15	Wonder Mountain	Argentiferous galena replacement bodies in an altered and fractured limestone along a limestone/quartz monzonite contact (Goodwin 1957).
18N	14E	31, 32	Kalley	Production (1949-51). Ore: Ore shipped averaged 7.62% Zn, 22.9% Pb, and minor Ag and Cu. Mineralization contained in replacement bodies in limestone containing galena, sphalerite, and minor chalcopyrite (Goodwin 1957).
16N	14E	15	Bullion (Mineral Hill)	Production (1916-17). Ore: 250 short tons yielding lead-copper-silver. Mineralization consists of jasper-quartz, hemimorphite, and malachite. Ore is localized in a fault zone in Goodsprings Dolomite (Patchick 1959 and Wright 1953).

Table XIV-1-2 Known Mineralized Areas, Occurrences, and Prospects

TWP	RGE	SEC.	PROPERTY	REMARKS
15N	13E	24	Unnamed Prospect	Half mile north of the Copper King Mine, shaft reaches to 300 feet. A bleached contact zone contains chrysocolla (Hewett 1956).
16N	13E	6	Copper Commander	See also Copper World (Hewett 1956).
17N	13E	14	Birney's Prospect	Shear zones containing chalcopyrite galena, fluorite, and fibrous sericite (Hewett 1956).
17N	13E	24	Benson Mine	Copper bearing pyrite in a shear zone contained in granite gneiss (Hewett 1956).
17 1/2N	13E	31, 32	Spar King	Ag-Au prospect (Goodwin 1957).
17N	13E	16	War Eagle (Douglas No. 1)	Fluorite - sericite bearing zone 200 feet long by ten feet wide containing 50-60% fluorite in minor fault in the Goodsprings Dolomite (Wright 1953).
17N	13E	21	Juniper (Clark Mtn., Kirfist, Kirfist #1)	Similar to War Eagle (Wright 1953).
15N	14E	4	Unnamed Prospect	100 foot shaft sink 200 north of the Clark Mtn. Fault. Minerals reported are malachite, azurite, and an olive vanadate (Hewett 1956).
15N	14E	28	Sunnyside Mine	Fracture mineralized with chalcopyrite shaft sunk into gneissic granite, with four levels (Hewett 1956).
15N	14E	28	Kewanee Mine	Gole-bearing quartz veins in quartz monzonite (Hewett 1956).
17N	14E	10	Columbia	Scheelite and Wolframite in quartz veins and rhyolite like near schist/granite contact.

Table XIV-1-3 Patented Mining Claims

TOWNSHIP	RANGE	NUMBER OF CLAIMS
19N	11E	1
17N	12 1/2E	1
17N	13E	7
16N	13E	9
15 1/2N	14E	2
15N	14E	3

Table XIV-1-4 Unpatented Mining Claims as of June 16, 1981

TOWNSHIP	RANGE	SECTION	NUMBER OF CLAIMS
19N	11E	6	1
		11	10
		13	2
		24	1
		26	1
		31	2
		32	4
		33	4
18N	11E	13	1
19N	12E	None	0
18 1/2N	12E	None	0
18N	12E	31	1
17N	12E	14	2
		34	1
16N	12E	22	2
		23	7
		26	1
		34	2
		35	1
15N	12E	7	3
17N	12 1/2E	24	2
		25	14
16N	12 1/2E	1	4
		12	4
19N	13E	None	0
18N	13E	4	4
		5	4
		23	1
17 1/2N	13E	24	4
		25	4
		26	3
		32	5

TOWNSHIP	RANGE	SECTION	NUMBER OF CLAIMS
17N	13E	1	3
		2	22
		3	19
		4	41
		5	41
		6	18
		7	6
		8	54
		9	72
		10	40
		11	20
		12	3
		13	4
		14	7
		15	39
		16	1
		19	6
		20	4
		21	3
		22	23
		23	39
		24	27
		25	3
		26	17
		27	4
		29	6
		30	9
		31	1
		32	3
		34	6
		35	2
16N	13E	2	29
		3	4
		5	6
		6	20
		7	6
		8	4
		9	3
		10	4
		11	37
		12	19
		13	8
		14	18
		15	4
		16	4
		17	4
		18	1
		20	4

Table XIV-1-4 Unpatented Mining Claims as of June 16, 1981 (continued)

TOWNSHIP	RANGE	SECTION	NUMBER OF CLAIMS
16N	13E	21	5
		22	4
		23	12
		24	20
		25	5
		26	9
		27	4
		28	4
		29	4
17 1/2N	13E	24	4
		25	4
16N	13E	31	2
		32	1
		33	4
		34	5
		35	17
15N	13E	1	4
		2	4
		3	4
		12	4
		13	4
		19	2
		22	1
		24	7
		25	12
		26	1
		36	4
18N	14E	28	1
		31	36
17N	14E	5	30
		6	70
		7	2
		8	11
		11	1
		12	1
		16	3
		17	4
		18	2
		19	2
		20	4
		21	5
		24	2
		28	4

Table XIV-1-4 Unpatented Mining Claims as of June 16, 1981 (continued)

TOWNSHIP	RANGE	SECTION	NUMBER OF CLAIMS
17N	14E	29	4
		30	6
		31	3
		32	5
		33	4
16N	14E	31	27
		32	11
15 1/2N	14E	19	29
		20	33
		21	5
		23	2
		24	2
		25	26
		26	4
		28	28
		29	30
		30	4
15 1/2N	14E	31	4
		32	13
		33	30
		34	7
15N	14E	1	1
		2	2
		4	18
		5	4
		6	7
		7	40
		8	4
		9	16
		10	5
		14	3
		15	30
		16	4
		18	28
		19	19
		20	26
		21	13
		22	23
		23	14
		24	1
		27	10
		28	20
		29	6
		30	22
		31	5
		32	9
		33	2

Table XIV-1-4 Unpatented Mining Claims as of June 16, 1981 (continued)

TOWNSHIP	RANGE	SECTION	NUMBER OF CLAIMS
14N	14E	6	1
		17	1
		18	2
		19	4
		29	2
		30	1
		32	1
13N	14E	7	1
		10	31
		11	14
		13	4
		14	3
		15	8
		25	4

Table XIV-1-5 Oil and Gas Leases

TOWNSHIP	RANGE	PENDING	APPLICANT
19N	11E	CA 5613	Snyder Oil Co.
		CA 5614	Snyder Oil Co.
		CA 5615	Snyder Oil Co.
		CA 5616	Snyder Oil Co.
		CA 5716	Cities Service Co.
		CA 5874	Phillips Petroleum Co.
		CA 5879	Phillips Petroleum Co.
		CA 5887	Phillips Petroleum Co.
		CA 5893	Phillips Petroleum Co.
18N	11E	CA 8370	General American Oil
		CA 8752	NARECO Co.
		CA 9619	NARECO Co.
19N	12E	CA 5519	Placid Oil Co.
		CA 5520	Placid Oil Co.
		CA 5521	Placid Oil Co.
		CA 5522	Placid Oil Co.
		CA 5662	Snyder Oil Co.
		CA 5663	Snyder Oil Co.
181/2 N	12E	CA 5526	Placid Oil Co.
		CA 5664	Snyder Oil Co.
		CA 5665	Snyder Oil Co.
		CA 5666	Snyder Oil Co.
18N	12E	CA 5881	Phillips Petroleum Co.
		CA 5882	Phillips Petroleum Co.
		CA 5883	Phillips Petroleum Co.
		CA 5884	Phillips Petroleum Co.
		CA 5885	Phillips Petroleum Co.
		CA 5886	Phillips Petroleum Co.
		CA 5890	Phillips Petroleum Co.
		CA 5891	Phillips Petroleum Co.
		CA 5892	Phillips Petroleum Co.
17N	12E	CA 5872	Phillips Petroleum Co.
		CA 5873	Phillips Petroleum Co.
		CA 5880	Phillips Petroleum Co.
		CA 5889	Phillips Petroleum Co.
		CA 5894	Phillips Petroleum Co.
		CA 5895	Phillips Petroleum Co.
		CA 5896	Phillips Petroleum Co.
		CA 5897	Phillips Petroleum Co.
		CA 5898	Phillips Petroleum Co.

Table XIV-1-5 Oil and Gas Leases (continued)

TOWNSHIP	RANGE	PENDING	APPLICANT
16N	12E	CA 8497	T. Connelly & R. David
		CA 8498	T. Connelly & R. David
15N	12E	CA 8497	T. Connelly & R. David
		CA 8500	T. Connelly & R. David
		CA 8749	NARECO Co.
		CA 8753	NARECO Co.
17N	12 1/2 E	CA 5875	Phillips Petroleum Co.
		CA 5876	Phillips Petroleum Co.
16N	12 1/2 E	CA 5877	Phillips Petroleum Co.
19N	13E	CA 5523	Placid Oil Co.
		CA 5524	Placid Oil Co.
		CA 5525	Placid Oil Co.
18N	13E	CA 5527	Placid Oil Co.
		CA 5528	Placid Oil Co.
		CA 5529	Placid Oil Co.
		CA 5530	Placid Oil Co.
		CA 5531	Placid Oil Co.
		CA 5532	Placid Oil Co.
		CA 5535	Placid Oil Co.
		CA 5536	Placid Oil Co.
		CA 5560	Snyder Oil Co.
		CA 5561	Snyder Oil Co.
		CA 5562	Snyder Oil Co.
		CA 5563	Snyder Oil Co.
		CA 5564	Snyder Oil Co.
		CA 5565	Snyder Oil Co.
		CA 5566	Snyder Oil Co.
		CA 5567	Snyder Oil Co.
		CA 5568	Snyder Oil Co.
17 1/2N	13E	CA 5573	Snyder Oil Co.
		CA 5574	Snyder Oil Co.
		CA 5631	Snyder Oil Co.
		CA 5648	Snyder Oil Co.
		CA 5649	Snyder Oil Co.
17N	13E	CA 5550	Snyder Oil Co.
		CA 5650	Snyder Oil Co.
		CA 5651	Snyder Oil Co.
		CA 5653	Snyder Oil Co.
		CA 5654	Snyder Oil Co.
		CA 5655	Snyder Oil Co.
		CA 5656	Snyder Oil Co.
		CA 5657	Snyder Oil Co.
		CA 5658	Snyder Oil Co.
		CA 5659	Snyder Oil Co.

Table XIV-1-5 Oil and Gas Leases (continued)

TOWNSHIP	RANGE	PENDING	APPLICANT
16N	13E	CA 5617	Snyder Oil Co.
		CA 5618	Snyder Oil Co.
		CA 5619	Snyder Oil Co.
		CA 5620	Snyder Oil Co.
		CA 5622	Snyder Oil Co.
		CA 5623	Snyder Oil Co.
		CA 5624	Snyder Oil Co.
		CA 5625	Snyder Oil Co.
15N	13E	CA 8499	T. Connelly & R. David
		CA 8500	T. Connelly & R. David
		CA 8501	T. Connelly & R. David
18N	14E	CA 5533	Placid Oil Co.
		CA 5534	Placid Oil Co.
		CA 5535	Placid Oil Co.
		CA 5669	Snyder Oil Co.
		CA 5570	Snyder Oil Co.
		CA 5571	Snyder Oil Co.
		CA 5572	Snyder Oil Co.
		Issued	Effective 7/1/81
17N	14E	CA 5551	Snyder Oil Co.
		CA 5554	Snyder Oil Co.
		CA 5555	Snyder Oil Co.
		CA 5556	Snyder Oil Co.
		CA 5557	Snyder Oil Co.
		CA 5558	Snyder Oil Co.
		CA 5559	Snyder Oil Co.
		CA 5604	Cities Service Co.
		Pending	
		CA 5628	Cities Service Co.
		Issued	Effective 7/1/81
16N	14E	CA 5589	Cities Service Co.
		CA 5600	Cities Service Co.
		CA 5601	Cities Serivce Co.
		CA 5604	Cities Service Co.
		CA 5605	Cities Service Co.
		CA 5606	Cities Service Co.
		Pending	
		CA 5628	Cities Service Co.
		CA 5629	Cities Serivce Co.
		CA 5660	Snyder Oil Co.
		CA 5661	Snyder Oil Co.

Table XIV-1-5 Oil and Gas Leases (continued)

TOWNSHIP	RANGE	PENDING	APPLICANT
15 1/2 N	14E	CA 5646	Snyder Oil Co.
		CA 5647	Snyder Oil Co.
		Issued	Effective7/1/81
15N	14E	CA 5595	Cities Service Co.
		CA 5596	Cities Service Co.
		CA 5598	Cities Service Co.
		Pending	
		CA 9147	Great Eastern Energy
14N	14E	CA 9150	Great Eastern Energy
		CA 9583	NARECO Co.
13N	14E	CA 9151	Great Eastern Energy
		CA 9582	NARECO Co.

Table XIV-1-6 Material Sales Sites

TOWNSHIP	RANGE	SECTIONS
16N	12E	27, 31, 33
15N	12E	6
16N	14E	34, 35

Mineral Deposit Types - An Overview

The mineral deposits in this GRA can be divided into several genetic types. The hydrothermal deposits, which form the bulk of the metallic mineral deposits in this GRA, are the most prevalent genetic type. These are all probably related to the intrusion of the Teutonia quartz monzonite and its satellite stocks in the area.

The emplacement of the Teutonia quartz monzonite was forceful, as shown by the well-developed breccia zones, fracture systems, and extensive stockworks in the overlying roof rocks in the area. A large volatile component associated with the batholith emplacement is also evident from the numerous descriptions of altered zones in the country rock and in the quartz monzonites.

By plotting mineralized areas, a number of hydrothermal centers were recognized. These centers are shown on Map 14h (Figure XIV-1-13), which also represents the major producers in the Clark Mountain District. The tonal anomaly study has shown that the alteration (as expressed by the reflectance of limonite) is more extensive than shown on Map 14h. This study also indicates that the area has excellent potential for new high-grade deposits in the Paleozoic country rocks surrounding the Teutonia quartz monzonite. There is also a very high probability of large, low-grade, disseminated deposits at depths under these hydrothermal systems, both in the country rocks and in the quartz monzonites.

The rare earth deposits in the GRA are essentially primary magmatic minerals in carbonatite units that intrude the Precambrian rocks in this area. Due to the economically important minerals present with carbonatites, exploration for further deposits of this type will continue in the GRA, especially along the known northwest-southeast trend.

Sedimentary processes have produced the limestone, gypsum, and gravel deposits in this area, and exploration by stratigraphic mapping will continue to outline these resources in the GRA.

Oil and gas exploration is very active in this area and a number of Federal leases have been issued. Because this is in the Overthrust Belt, initial drilling depths will be roughly in the 12,000 to 15,000-foot range. By the mid-1980s the hydrocarbon potential of this area will be known to a much higher degree of confidence than it is now.

Land Classification for G-E-M Resources Potential

Locatable Metallic - Class 1a (see Classification Table, Figure XIV-1-11)

Area 1 contains (Map 14a, Figure XIV-1-14) the world's largest producer of rare earth elements (REE) and supplies about 97 percent of the U.S. domestic consumption. Reserves are large and should last for many decades at the current rate of production. The area includes the principal remaining related known deposits of REE in the region (not currently in production). The potential is high for production of thorium and barite from the Mountain Pass Mine and throughout the mineralized area. Additional supporting

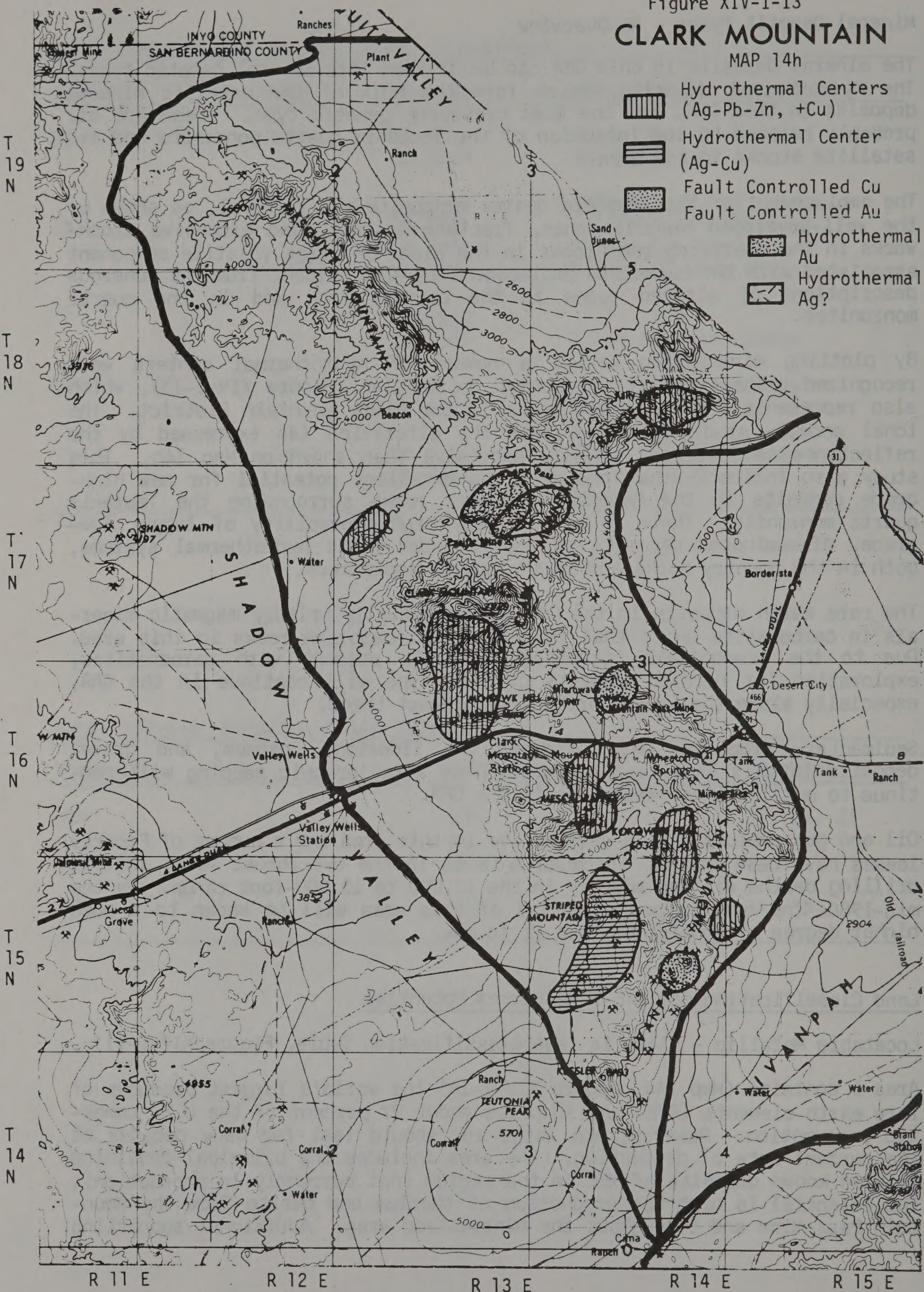
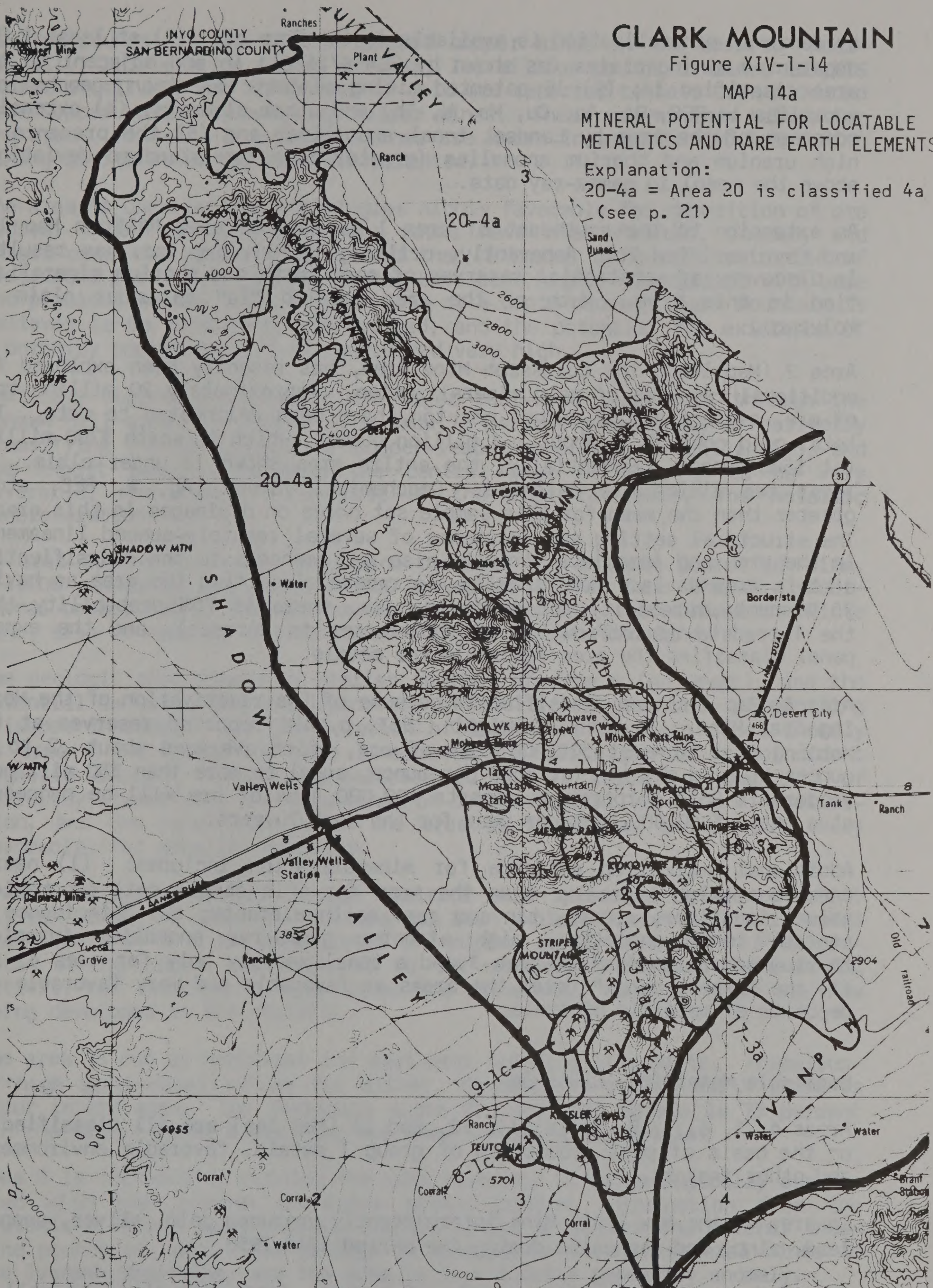


Figure XIV-1-13

CLARK MOUNTAIN

MAP 14h



CLARK MOUNTAIN

Figure XIV-1-14

MAP 14a

MINERAL POTENTIAL FOR LOCATABLE METALLICS AND RARE EARTH ELEMENTS

Explanation:
20-4a = Area 20 is classified 4a
(see p. 21)

evidence of mineralization is available in the form of: (1) at least 1,828 unpatented mining claims (as shown by BLM 6/21/81) in and adjacent to the area classified 1a; (2) 18 patented mining claims; (3) strong geochemical anomalies in REE, Ba, Ag, Cu, Mo, W, Th, and other elements; (4) extensive coverage of the area by Landsat tonal anomalies; and (5) the presence of high uranium and thorium anomalies (greater than two standard deviations above the mean) in gamma-ray data.

An extension to the southeast of area 1 is labeled area "A1" on Map 14a and is classified 2c. Apparently, drilling by Molycorp Inc. has resulted in discovery of substantial reserves of rare earth and thorium mineralization in this area. Much of the area labeled "1a" is under claim by Molycorp.

Area 2 (Map 14a), the Colosseum Mine area, has recently been explored for additional reserves of gold mineralization. Approximately 20 million tons of ore, averaging 0.07 ounces per ton, have been delineated to date. The total gold content is about 1.4 million ounces, which is worth $700 million (at $500/ounce). Essentially, the entire area shown is under claim. At least two claims are patented. Geochemical values (Ag, W, REE, etc.) greater than the mean for this sample set occur on drainages in this area. The structural setting and existence of several remotely-sensed lineaments in the area and immediate vicinity also add emphasis to the classification of this area as 1a. Additionally, Terradata classified the area as having 75 percent probability for gold (that is, there is 75% probability that the Terradata classification of occurrences is correct), and the expert panel classified the area favorable for metals.

Area 3 (Map 14a) was classified 1a because of the reactivation of the Morning Star Mine. In area 3, Wright (1953, p. 48) reported reserves at the Morning Star Mine at 500,000 tons of ore, which averaged about .2 to .3 ounces of gold per ton (at $500 per ounce, equal to more than $50 million). Vanderbilt Gold Corporation reports 400,000 tons of ore will be processed at a rate of 60,000 tons per year for the next 7 years.

Additional supporting evidence for mineralization includes: (1) nearby anomalous (high = greater than the mean for this sample set) geochemical values in silver, copper, tin and rare earth elements; (2) coincidence of Landsat tonal anomalies, high airborne gamma-ray anomalies (uranium, thorium and potassium) at area 3 and a tonal anomaly only for area 4; and (3) the "expert panel" rated the areas as favorable and very favorable for deposits of metallic minerals.

Locatable Metallic - Class 1c

Areas 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13 (Map 14a) are all classified 1c on the basis of past production of group 1 metals, favorable environment, and other factors.

In area 4, the New Trail Mine intermittently produced gold, silver, copper, lead, zinc, and magnesite during the period 1916-1950.

Area 5 has produced major amounts of copper, lead, and zinc, as well as some gold and silver. The Copper World, with production exceeding 2.4

million pounds, is one of the largest copper mines in the desert. Additionally, 3.15 million pounds of lead, 1.1 million pounds of zinc, 153,676 ounces of silver, and 323 ounces of gold are reported to have been produced from Copper World, Mohawk, and Keiper mines. These are minimum values for the area. At least 10 separate mines are known in area 5. At least five mining claims at Mohawk Hill are patented.

The area is underlain by lithologies highly favorable for deposition of ore bodies. The Paleozoic carbonate rocks have been faulted, folded, and thrust over the older terrane, and then intruded by quartz monzonite of Cretaceous age. These contact zones have been highly mineralized with base and precious metals. The contact zone at a depth beneath Clark Mountain is believed to be thoroughly mineralized, and the potential for existence of a porphyry copper deposit is considered very high.

Ancillary supportive data include major east-west lineaments through the Mohawk Hill area. Terradata maps show 75 percent probability of correctly classifying the occurrences of copper-lead-zinc-silver mineralization, and the expert panel determined the central part of area 5 to be very favorable, and most of the rest of the area favorable, for metallic mineralization.

In area 6, the Carbonate King Mine produced 5.5 million pounds of zinc, 174,000 pounds of lead, and 58,000 ounces of silver from 1941-51. Additional production of 370,000 pounds of lead has been reported at the Piute Mine, also in area 6. The Carbonate King is on patented land.

The geologic environment is similar to that of area 4 (adjacent), and the potential is excellent for discovery of additional reserves. Supporting evidence includes: (1) the location of area 6 in the same tonal anomaly as area 4 and along the same lineaments and (2) a partially coincident magnetic anomaly. Terradata believes it has 75 percent probability of correctly classifying the occurrence of copper-lead-silver-zinc mineralization, and the panel classified the area as favorable, and in part very favorable, for metallic deposits.

Area 7 includes the Old Ivanpah district which produced between 3 and 5 million ounces of silver. The area has been explored recently and is under claim (part of a block of at least 591 claims on BLM records). Four patented mining claims are adjacent to the unpatented claims. Past mining activity has resulted in many mines and prospects, some of which are now being developed in the district.

The area is cut by northwest and east-west trending lineaments. Anomalously high geochemical values for silver, tungsten, and rare earth elements occur in the area. The Terradata score for combined metals is 75 percent and the expert panel classified the area favorable for metals.

Area 8 is technically outside the GRA; however, it is geologically associated with the Ivanpah Mountains mineralization. Production from the Teutonia Mine was approximately 12,000 ounces of silver and several thousand pounds of lead. The geology is similar to that of several mines in the Ivanpah Mountains, and the area is in a thorium gamma-ray anomaly.

Area 9 has the only known tin mine in the CDCA. Production records are vague; however, the property was mined during the years 1939 to 1944 and produced tin, tungsten, and copper. The area is currently under claim. The deposit occurs in a contact zone between the Goodsprings Dolomite and the Teutonia quartz monzonite. Coincident tonal, and high, gamma-ray uranium, thorium, and potassium anomalies occur immediately adjacent to area 9. The expert panel classified the area as favorable for metallic minerals.

Area 10 has produced unknown, probably small, quantities of tungsten, copper, silver, gold, zinc, and lead. The geologic environment, the contact zone of Sultan Limestone and Goodsprings Dolomite with the Teutonia quartz monzonite, is exceptionally favorable for deposits of tungsten and other base metals. The quartz monzonite adjacent to the mineralized area shows up as a tonal anomaly, and most of the area is rated by Terradata as having 75 percent probability of being correctly classified for the occurrence of copper-lead-silver-zinc.

Unknown quantities of gold, copper, lead, and silver ores were removed from a minimum of 11 mines in area 11. Mineralization occurs in quartz veins in Paleozoic limestones and dolomites, as well as in the Teutonia quartz monzonite. A nearby geochemical sample is anomalously high in silver, rare earth elements, and other elements. The area is covered by a large tonal anomaly and partially includes high uranium, thorium, and potassium gamma-ray anomalies.

The Mollusk, Blue Buzzard, and Iron Horse mines produced thousands of pounds of lead in area 12. Recorded mine production includes gold, silver, copper, and zinc. Most of the area is currently under claim, and the Mollusk Mine is patented. The area has anomalously high geochemical values in silver, lead, and zinc, is magnetically high, is adjacent to tonal anomalies, and is rated 75 percent probability for being correctly classified for occurrence of copper-lead-silver-zinc by Terradata. The expert panel found it to be a favorable area.

Past production of lead, zinc, silver, and copper is reported from the Umberci and Kalley mines in the northeastern Clark Mountains of area 13. The area is currently under claim, the lithology is similar to that at other base metal deposits, and part of the area is underlain by a magnetic high.

Locatable Metallic - Classes 2 and 3

Area 14, classified 2b, produced unknown amounts of stibnite with barite in veins cutting a schistose granite. The area is in the major zone of tonal anomalies adjacent to the major northwest-trending lineaments of the GRA. The workings were not examined underground, but a small pile of ore material at the mine indicates the probable presence of antimony mineralization that was not removed during mining. Terradata classified the area 75 percent for gold and for copper-lead-silver-zinc mineralization. The expert panel map indicates a favorable environment for metals.

Area 15 is classified 3a for the presence of the Green's and Benson mines and several other prospects. Tungsten and copper mineralization are reported at these mines. The area is largely under claim, and most of it

falls in the tonal anomalies of the northern Clark Mountains. Located at the intersection of northwest and east-west-trending lineaments and having anomalously high tungsten, rare earth, and silver geochemical values suggest a very favorable environment for mineralization. The probability of correct Terradata classification for copper-lead-silver-zinc is 75 percent, and the expert panel rated the area favorable for metals.

Area 16 is classified 3a. The Ivanpah Mammoth Mine explored copper, silver, and gold mineralization on the southern end of the area. In excess of 60 unpatented claims have been recorded on BLM files to date. Tonal and uranium gamma-ray anomalies cover much of the area. Anomalously high geochemical values in copper, molybdenum, silver, lead, and rare earth elements occur throughout the area. The west-central part of the area is underlain by a magnetic high, and northwest-trending lineaments cut the western part. Terradata rated the area high for gold and copper-lead-silver-zinc mineralization; the expert panel rated the area favorable and very favorable for metals.

Area 17 is classified 3a. Past production of copper, gold, silver, lead, and zinc is recorded from the Allured Mine. The area is under claim, both patented and unpatented. Other small parts of the area have tonal and high potassium gamma-ray anomalies. Silver and copper and possibly tin are anomalously high in the geochemical sample taken downstream. The area lies between two major northwest-trending lineaments. The probability of Terradata correctly classifying the area for copper-lead-silver-zinc is 75 percent, and the expert panel rated the area favorable and very favorable for metals.

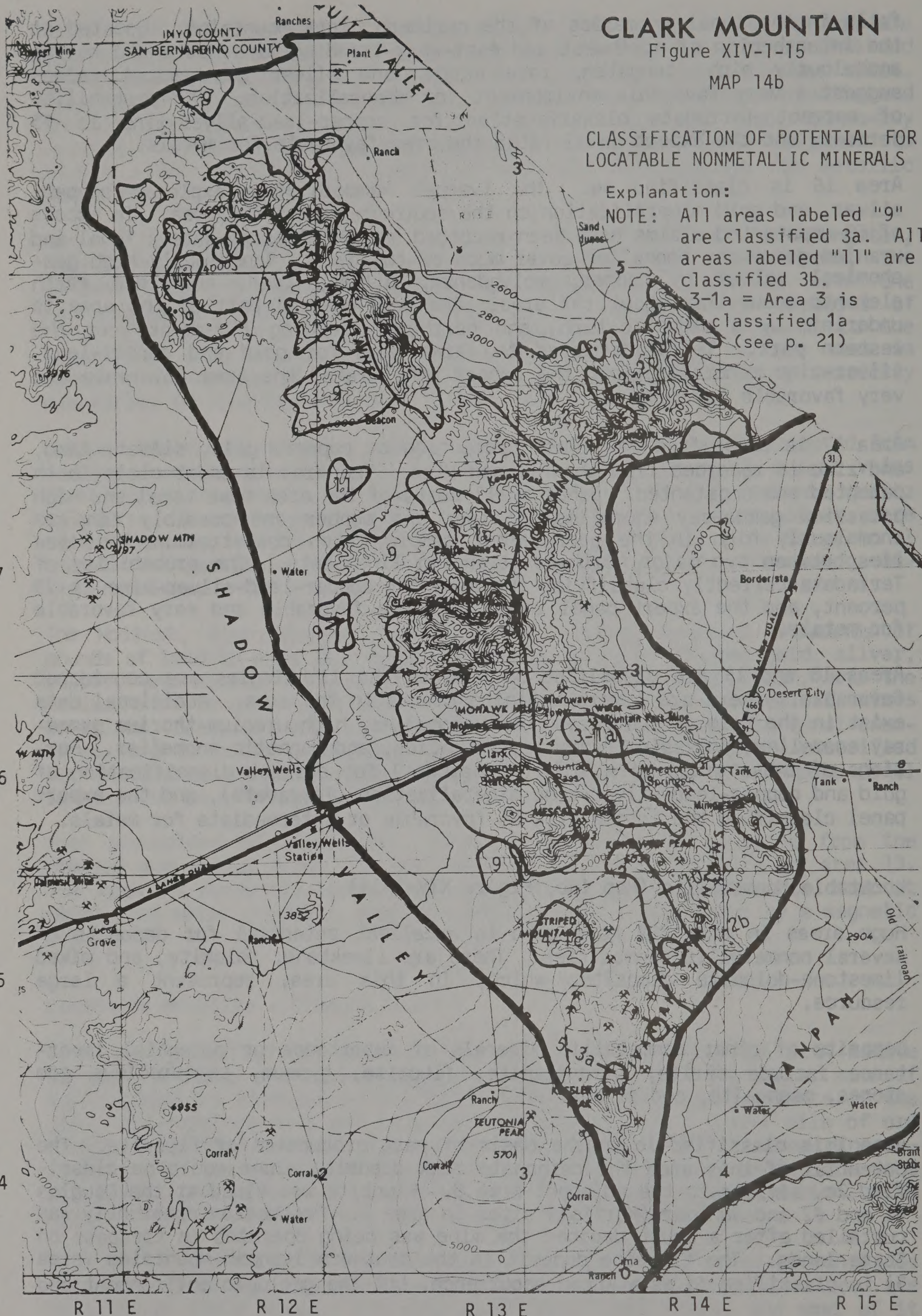
Areas 18 and 19 are classified 3b because the lithologies are considered favorable. There are numerous mining claims in the area. Additional data exist in the form of scattered tonal anomalies, high uranium-thorium gamma-ray anomalies, potassium gamma-ray anomalies, and magnetic anomalies. Portions of these areas rate high (75 percent) for correct classification of gold and copper-lead-silver-zinc mineralization (Terradata), and the expert panel classified the entire area as favorable or intermediate for metals.

Locatable Nonmetallic (Map 14b, Figure XIV-1-15)

Huge areas in this GRA have good to excellent potential for deposits of several nonmetallic commodities. These are limestone, dolomite, and mixed limestone-dolomite deposits, which, in this area, represent a large resource.

Deposits of other nonmetallic minerals of importance or potential importance include barite, strontianite, fluorite, gypsum, semiprecious gem stones, magnesite, and silica.

Area 1 is classified 1c on the basis of past production of fluorite. The potential of this area for carbonate rock deposits alone would be classified 2c, similar to the adjacent area 8. Fluorite was mined at the Douglas #1 and #2 and Juniper (Korfist) sites in area 1. Production apparently was curtailed after a court decided the mine was being operated in trespass on State lands. The fluorite deposit in the southern Ivanpah Mountains (area 5) is classified 3a as a known occurrence, but the geologic environment and



CLARK MOUNTAIN

Figure XIV-1-15

MAP 14b

CLASSIFICATION OF POTENTIAL FOR LOCATABLE NONMETALLIC MINERALS

Explanation:

NOTE: All areas labeled "9" are classified 3a. All areas labeled "11" are classified 3b. 3-1a = Area 3 is classified 1a (see p. 21)

surface evidence suggest the area is not particularly well suited for large, extensive deposits.

Gypsum is known to occur in area 2 (classified 2b), and the value (in 1978 dollars) is estimated at $618 million, in place. The area is covered by unpatented mining claims.

Barite and strontianite are being mined at the Mountain Pass operation (area 3); however, it is not yet known if the mill circuit is set up to recover these minerals. The area has been classified la on the assumption that they are being mined. Although barite can be extracted from this ore, presently it is not marketed. However, it is certain that if no other values were present (e.g., REE), the strontianite content would be insufficient to support the costs of mining and milling to recover it. Production can only occur, economically, as a byproduct of other mineral production at this time.

In recent years, portions of the Copper World Mine (area 6) have been worked intermittently to recover semi-precious gemstones (azurite and malachite). The quantity produced is unknown; however, the quality appears high. The area is classified 2a.

Several hundred tons of magnesite have been mined in area 7 at the New Trail Mine. However, the quantity remaining is not known. The area is classified 2b on past production only.

Limestone and/or dolomite deposits occur in all areas labeled 1, 4, 6, 8, 10 and 11. Known resources in areas 4 and 10 (both classed 1c) are large (on the order of $1 billion each at 1978 prices). Area 4 (Striped Mountain) has reserves of 100 million short tons and resources of an additional 300 million short tons. Area 10 (Kokoweef) is possibly of comparable size. All areas labeled 8 have limestone or dolomite localities cited in the literature and are classed 2c for this evaluation. The geologic terrane is highly favorable for occurrence of extensive and potentially important deposits of limestone in each of the three areas (Mescal-Mohawk-Clark, northeastern Clark Mountains, and Mesquite Range).

Finally, substantial areas (all labeled 9 on the map) of this GRA have potential and/or identified deposits of quartzite sufficiently pure to be used in various silica applications. Three identified deposits occur in widely separated outcroppings of Prospect Mountain Quartzite; therefore, all areas of Prospect Mountain Quartzite (as mapped by Hewett (1956)) are shown as having potential for sources of silica materials. Another identified occurrence is located in the earlier Precambrain granite gneiss complex of the southeastern part of the GRA. The deposit is listed as having silica, mica, and feldspar; therefore, it is assumed to be a granite pegmatite. The size and quality have not been estimated. Each of the areas labeled 9 has been classified 3a. Also, seven separate areas are labeled 11 on the Locatable Nonmetallic Minerals map. The Goodsprings Dolomite crops out in each of these areas; this represents potentially valuable resources of limestone and/or dolomite. However, no deposits of economic significance have been specifically identified in these areas. Therefore, these seven areas are classified 3b.

Uranium-Thorium (Map 14c, Figure XIV-1-16)

Several types of data available for the Clark Mountain GRA suggest the potential for deposits containing uranium and/or thorium. These data are: current gamma-ray anomalies (uranium and thorium), geochemical anomalies (thorium), reported occurrences, expert panel evaluation, claims, and favorable geologic environment. Also, thorium is present but, in concentrations too low to currently be recovered from the Mountain Pass Mine.

Area 1 is classified 1a because all of the above types of data are available and define the potential for thorium.

Areas 2 through 6 are all in the same geologic terrane as area 1 and are therefore favorable. Area 2 also has gamma-ray (uranium) and geochemical (thorium) anomalies, known occurrences, and mining claims. Area 3 is defined principally on the basis of known mineralization discovered by core drilling in the area. The evaluated in-place worth of the thorium resource of areas 1, 2, and 3 combined exceeds $6.3 billion (1978 prices). The potential for presence of uranium mineralization in these areas is not as well documented; however, the presence of gamma-ray uranium anomalies and its reported occurrence at the Mountain Pass Mine suggest substantial potential.

Areas 4, 5, and 6 are considered favorable terrane for uranium and/or thorium mineralization because the country rock is similar to that in areas 1, 2, and 3. Also, at least one uranium occurrence is reported in area 6.

Areas 7, 8, and 9 are classified 3b on the basis of uranium and/or thorium gamma-ray anomalies. Areas 7 and 8 are underlain by the Teutonia quartz monzonite and alluvial debris derived therefrom. The anomalies could reasonably be expected to relate to mineralization (uranium and/or thorium) in the area. However, in area 9 the anomaly is in a Quaternary playa that is virtually surrounded by sedimentary rocks of Paleozoic to Precambrian ages.

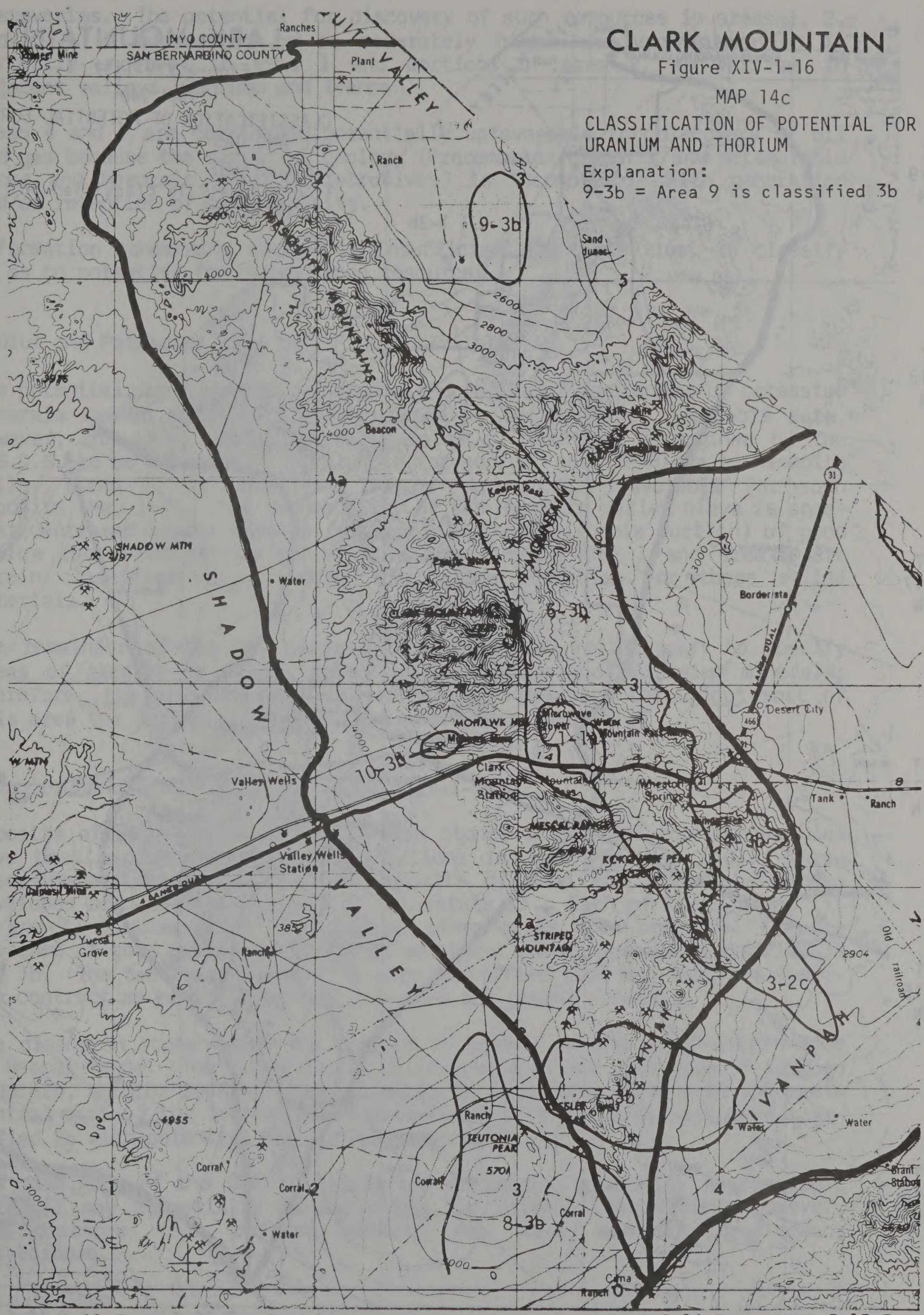
In area 10, occurrences of uranium are reported at the Mohawk Mine and adjacent workings. The significance of the occurrences is not known; however, potential for a large deposit of uranium mineralization is not considered high. This area is patented land.

The rest of the GRA is classified 4a because of the lack of relevant data.

Oil and Gas (Map 14e, Figure XIV-1-17)

The potential for the discovery of oil and gas resources in the Clark Mountain GRA is considered to be moderately high, based on geologic inference. However, the Overthrust Belt, where intense exploration activity has taken place during the past two years in other states, is known to continue into this GRA. The units of most interest are the Paleozoic sedimentary rocks similar to those exposed in the various thrust sheets found in the Clark Mountain area.

Areas 1, 2, and 3 are classified 3b due to the presence of the Paleozoic units of the Overthrust Belt. Additionally, areas 1 and 3 have been classified by the U.S.G.S. as basins prospectively valuable for oil and gas


CLARK MOUNTAIN
Figure XIV-1-16
MAP 14c
CLASSIFICATION OF POTENTIAL FOR URANIUM AND THORIUM
Explanation:
9-3b = Area 9 is classified 3b
INYO COUNTY
SAN BERNARDINO COUNTY
SHADOW VALLEY
IVANPAH
9-3b
6-3b
10-3b
1-1b
4-3b
3-2c
8-3b
T 19 N
T 18 N
T 17 N
T 16 N
T 15 N
T 14 N
R 11 E
R 12 E
R 13 E
R 14 E
R 15 E

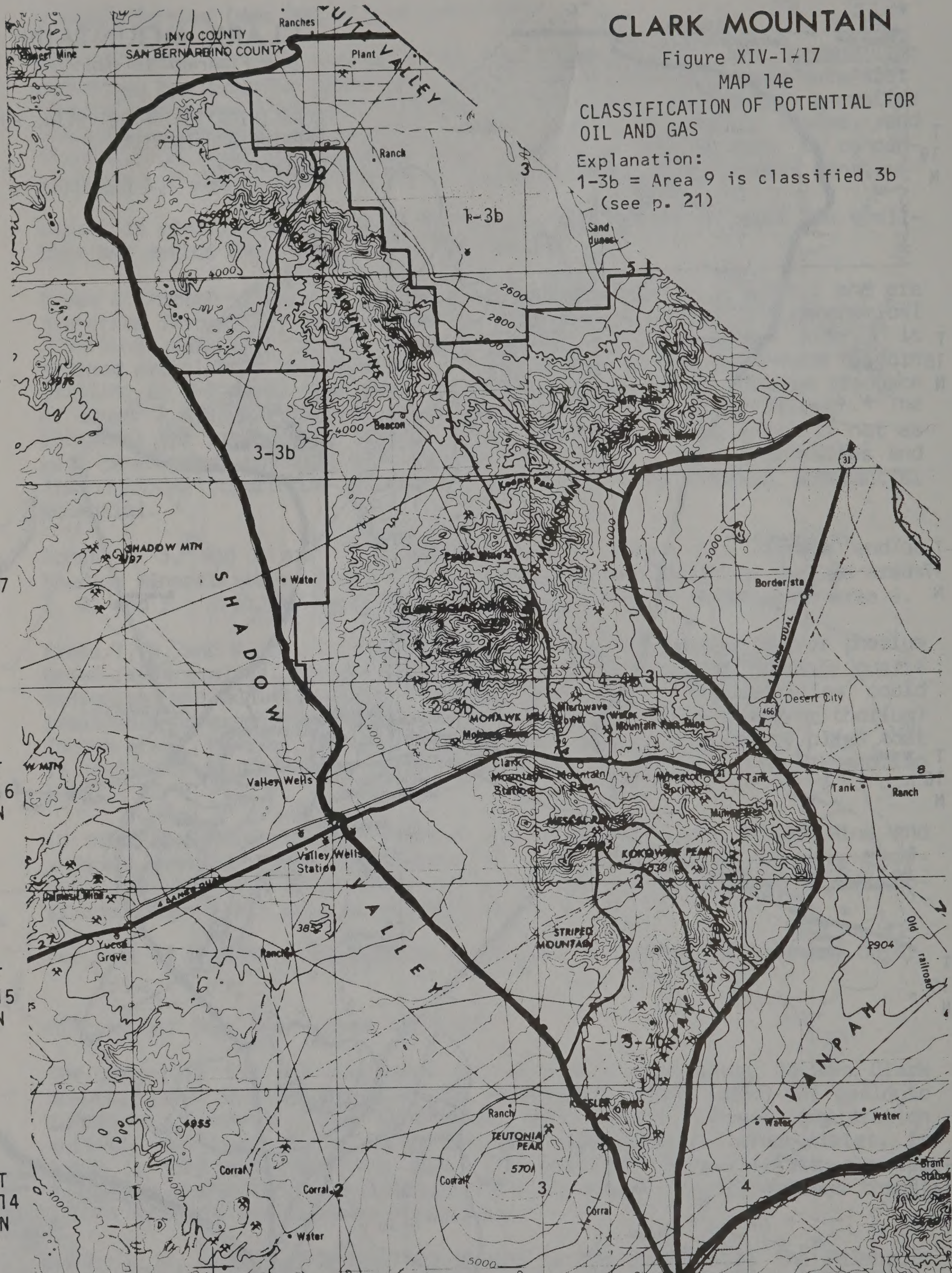
CLARK MOUNTAIN

Figure XIV-1-17

MAP 14e

CLASSIFICATION OF POTENTIAL FOR OIL AND GAS

Explanation:
1-3b = Area 9 is classified 3b
(see p. 21)



discoveries. The potential for discovery of such resources in areas 1, 2, and/or 3 is considered to be moderately high. Active exploration is currently underway in area 1 and portions of area 2, as well as in adjacent valleys (Pahrump and Ivanpah).

Areas 4 and 5 are considered potentially unfavorable for discovery of oil and gas because the surficial geology (Precambrian granitic and metamorphic rocks and Mesozoic granitic intrusives) is incompatible with generation and/or retention of such deposits.

Information concerning area 6 is insufficient, at this time, to classify it as to potential for hydrocarbon resources.

Sodium and Potassium (Map 14f, Figure XIV-1-18)

The potential for discovery of economic deposits of sodium and/or potassium minerals cannot be critically evaluated on the basis of available data. However, the playa at Valley Wells (area 1) has been determined by the U.S.G.S. to be prospectively valuable for sodium, and the playa in Mesquite Valley (area 2) is considered to be geologically favorable for such deposits (Map 14f). The favorability of the Mesquite Valley playa is somewhat decreased by the absence (at least in the California portion) of good source rocks for sodium and/or potassium. Both area 1 and area 2 are herein classified 3b as having speculative potential for these saline materials.

The remainder of the GRA (area 3) is not known well enough to specify areas of greater or lesser potential for sodium and potassium minerals; therefore, the area has been classified 4a. However, throughout most of this area the surficial geology does not appear favorable.

Salable Commodities (Map 14g, Figure XIV-1-19)

Deposits of sand and gravel, dimension stone, slate, and roofing granules have been exploited at various locations in the GRA (Map 14g). Three areas (seven deposits) in which deposits of sand and gravel have been developed are located adjacent to Interstate 15. Each of these areas (1, 2, and 3) is classified 2b. Several other areas have potential for the presence of good quality deposits of sand and gravel and are classified 3a and 3b. The two areas labeled 3a were identified from the landform analysis contract as having potential for sand and gravel deposits.

The dimension stone quarry is located in area 4 on the southeastern side of Mescal Range. The slate quarry is in area 5 on the west side of Striped Mountain, and the roofing granules sites is located in area 6 in the west-central part of the Ivanpah Mountains. Each of these areas has been classified 2b with potential for future production.

The remainder of the GRA is classified 4c because virtually any geologic material may potentially be exploited for salable commodities; however, the distance from current markets may make economic development unfavorable.

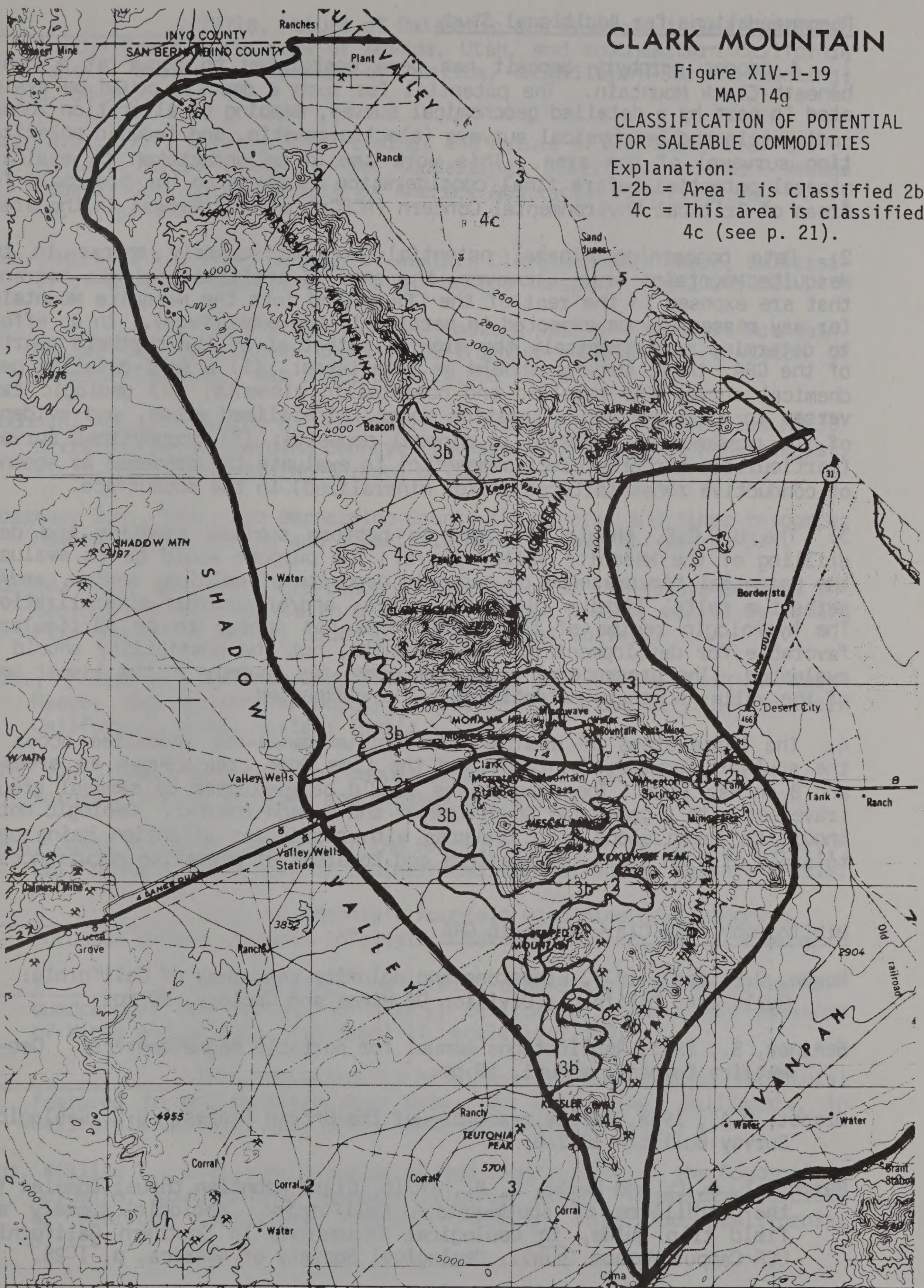
CLARK MOUNTAIN

Figure XIV-1-18

MAP 14f

CLASSIFICATION OF POTENTIAL FOR SODIUM AND POTASSIUM

Explanation:
2-3b = Area 2 is classified 3b (see p.21)


CLARK MOUNTAIN
Figure XIV-1-19
MAP 14g
CLASSIFICATION OF POTENTIAL
FOR SALEABLE COMMODITIES
Explanation:
1-2b = Area 1 is classified 2b.
4c = This area is classified
4c (see p. 21).
INYO COUNTY
SAN BERNARDINO COUNTY
SHADOW VALLEY
IVANPAH
R 11 E
R 12 E
R 13 E
R 14 E
R 15 E
T 19 N
T 18 N
T 17 N
T 16 N
T 15 N
T 14 N

Recommendations for Additional Study

1. A copper porphyry deposit has been postulated to occur at a depth beneath Clark Mountain. The potential for such a deposit could be evaluated in part by a detailed geochemical survey, mapping of alteration zones, radiometric and geophysical surveys (electromagnetic, and induced polarization surveys) of the area. This work should be undertaken to evaluate mineral potential before final consideration is given to the proposals for Areas of Critical Environmental Concern (ACECs) and wilderness in the area.

2. Data concerning mineral potential are particularly sparse in the Mesquite Mountains area. However, the same mineralized geologic terranes that are exposed in the rest of the GRA extend into the Mesquite Mountains (or may reasonably be expected to persist in the subsurface). In an effort to determine more precisely the mineral potential of the northern quarter of the GRA, three surveys should be undertaken: (1) a semi-detailed geochemical survey for metallic and nonmetallic elements; (2) geologic traverses to find and map alteration zones, mineralized areas, and evidence of the presence of nonmetallic mineral deposits; (3) geophysical surveys (particularly airborne electromagnetic) to evaluate the presence or absence of conductive zones (altered and/or mineralized) in the subsurface.

3. The U.S.G.S. should be urged to perform surface sampling and deep drilling of the Mesquite Valley playa. The purpose would be to evaluate the potential for presence of economic deposits of calcium, sodium, and/or potassium salts, lithium clays or brines, and/or uranium mineralization. The hydrologic regime of the valley does not appear to be particularly favorable for development of such deposits, but the possibility should be evaluated. The presence of a uranium gamma-ray anomaly in the lowest part of the valley suggests potential for the unexpected.

4. The large areas of uranium and thorium gamma-ray anomalies occur in the southern Ivanpah Mountains and the Cima Dome area (shown as areas 7 and 8 on Map 14c). These anomalies should be evaluated by several ground traverses with a gamma-ray spectrometer and a magnetometer. Geologic notes should be taken along each traverse with particular attention being paid to areas of high gamma-ray readings and to areas of pegmatite occurrences.

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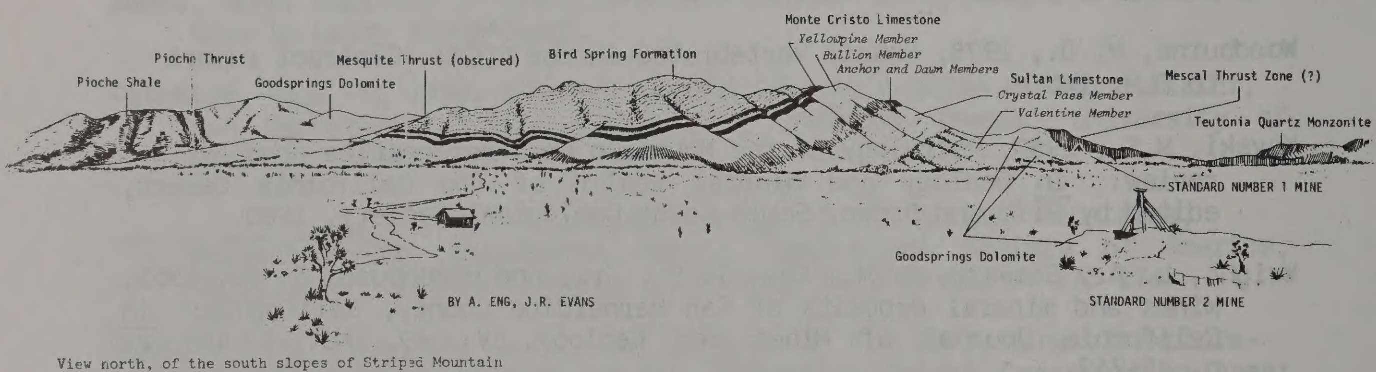


View north, of the south slopes of Striped Mountain

Part 2

Preliminary Analysis of Economic Geology, Mineral Commodities, and Related Socioeconomics of the California Desert Conservation Area

INTRODUCTION

The CDCA has produced or is capable of producing from known deposits approximately $232 billion worth of GEM resources. Approximately $18 billion is in past production, $215 billion is potentially available as reserves and resources. Due to incomplete records and the limited amount of time available to complete this analysis, this is a minimum approximation of the in-place values of 46 commodities. Rather than use the most recent data available for each resource, uniformity was obtained by using 1979 values, or as close to 1979 values as possible. The commodities found in the desert that were not analyzed would increase the total value of the mineral resources of the CDCA.

An investigation of the economic geology, mineral commodities and mineral economics of the California Desert Conservation Area (CDCA) was carried out between December 1979 and July 1980. Its purpose was to provide a preliminary appraisal of the mineral resources in the CDCA and to obtain a preliminary assessment of the mineral activities in the desert in terms of past, present, and future conditions.

This preliminary analysis is expected, as part of the California Desert Plan implementation, to be expanded and completed during the next five years. A more comprehensive overview of the mineral resources and economic potential of the CDCA will then be possible.

Of the 46 known mineral commodities in the CDCA, 25 were chosen for analysis and documentation. These commodities were chosen on the basis of four criteria of significance: (1) the commodity is on the official strategic minerals list (as compiled by the Federal Emergency Management Agency) and is critical to national security; (2) the United States imports 50% or more of this commodity for domestic consumption (as compiled by the U.S. Bureau of Mines); (3) the United States is a major exporter of this commodity (as compiled by the U.S. Bureau of Mines), which therefore contributes to the balance of payments in our nonfuel foreign trade; and (4) the commodity is of economic importance in the local (California) or regional (U.S.) markets (from U.S. Bureau of Mines data). Table XIV-2-1 summarizes the results of this analysis.

For each commodity, a separate report was prepared using U.S. Bureau of Mines, U.S. Department of Energy, and other publications. Information was compiled on the uses, domestic consumption, projected supply and demand trends, production (U.S., California, and CDCA), substitutes, and 1979 prices of each commodity. Each commodity report includes a listing of the deposits, their geographic locations in the CDCA, the GEM Resource Area (GRA), and the commodity's 1979 dollar values. References used in the report are also given. Map XIV-2-1 shows the location of the nonenergy locatable and leasable mineral deposits compiled in this study and is keyed to the lists that accompany the commodity reports.

Table XIV-2-1
MINERAL STATUS IN THE CDCA AND MARKET STATUS
OF THESE COMMODITIES AS A FUNCTION OF THE U.S. ECONOMY

COMMODITY	Production to 1981		Reserves & Resources (1981)		U.S. Consumption (1979)[1/]		To 1990[1/] Projected Rate of Annual Demand	Current (1981) Activity in CDCA
	Value ($ x 10^6)	Amount	Value ($ x 10^6)	Amount	Net Import %	Net Export %		
GROUP I								
Copper	13.648	14,628,287 lb	925.560	992,025,150 lb	14	--	--	Dormant
Lead	185.562	352,511,589 lb	481.130	914,000,000 lb	4	--	1.3%	Dormant
Manganese	243.180	1,737,000 lt	875.000	6,250,000 lt	98	--	--	Dormant
Molybdenum	--	None	15,525.000	2,070,000,000 lb	--	119	4.2%	Exploration
Silver	648.165	58,345,952 oz	3,643.776	328,002,170 oz	42	--	3.1%	Active
Talc	130.813	1,882,201 st	285.507	4,108,000 st	--	.1	2.6%	Active
Thorium	--	None	7.102	602,400 lb	100	--	4.5%	No Recovery
Tin	0.362	48,000 lb	37.700	5,000,000 lb	80	--	1.0%	Dormant
Tungsten	150.302	1,128,987 stu	1,168.881	8,780,000 stu	58	--	5.0%	Active
Zinc	38.569	103,404,040 lb	0.933	2,500,000 lb	63	--	1.1%	Dormant
TOTAL GROUP I	1,410.601		22,950.589					
GROUP II								
Gold	880.207	2,862,462 oz	768.507	2,499,209 oz	50	--	2.2%	Active
Potash	--	NA	15,999.190	136,745,180 MT	66	--	2.2%	Active
Strontium	0.454	8,540 st	1,418.304	26,700,000 st	100	--	1.4%	Dormant
TOTAL GROUP II	880.661		18,186.001					
GROUP III								
Borates	7,724.940	22,753,861 st	27,065.970	79,723,041 st	--	293	--	Active
Kyanite	1.953	31,000 st	234.990	3,730,000 st	--	42	3.0%	Dormant
Lithium	.707	22,600 st	39.709	1,268,655 st	--	75	5.7%	Dormant
Rare Earths	400.000	250,000 st	5,407.720	3,379,200 st	--	NA	5.2%	Active
Sodium Carbonate	--	NA	45,185.000	700,000,000 st	--	13	1.8%	Active
Uranium	1.375	16.15st	1,083.407	12,728,000 st	--	36	8.8%	Exploration
TOTAL GROUP III	8,128.975		79,016.796					

Table XIV-2-1 (Continued)
MINERAL STATUS IN THE CDCA AND MARKET STATUS
OF THESE COMMODITIES AS A FUNCTION OF THE U.S. ECONOMY

COMMODITY	Production to 1981		Reserves & Resources (1981)		U.S. Consumption (1979)1/		To 1990 1/ Projected Rate of Annual Demand	Current (1981) Activity in CDCA
	Value ($\$ \times 10^6$)	Amount	Value ($\$ \times 10^6$)	Amount	Net Import %	Net Export %		
GROUP IV 2/								
Barite	.025	1,000 st	314.960	12,700,000 st	38	--	4.0%	Development
Clay	--	NA	11,066.453	460,335,000 st	--	6	3.0%	Active
Gypsum	126.270	18,487,864 st	19,537.670	2,860,273,831 st	35	--	2.5%	Active
Iron	7,259.492	222,410,900 lt	23,851.000	730,743,571 lt	25	--	1.6%	Active
Limestone	482.800	120,700,000 st	11,308.000	2,827,000,000 st	3	--	2.5%	Active
Sand & Gravel	--	NA	250.488	99,400,000 st	--	.2	1.1%	Active
Sodium Sulfate	.139	2,500 st	24,497.362	439,888,000 st	9	--	2.0%	Active
Zeolite	--	NA	3,715.625	29,725,000 st	--	NA	--	Active
TOTAL GROUP IV	7,868.726		94,541.558					
GRAND TOTAL	18,288.963		214,694.944					

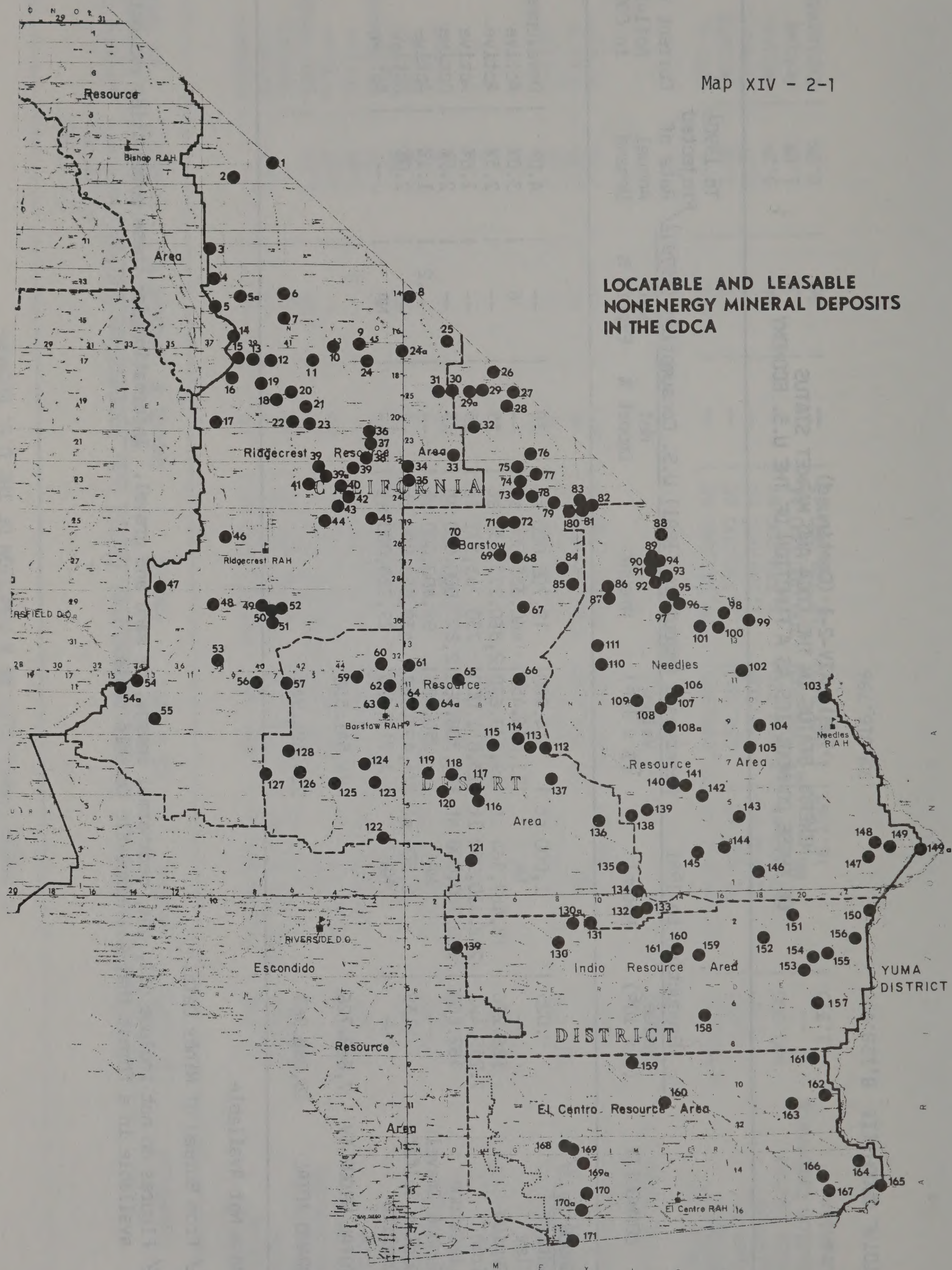
NA = Not Available

1/ From Bureau of Mines Data.

2/ Figures do not include oil, gas, geothermal energy, or sand and gravel. Information for these commodities was not available in a format that was adaptable to this table.

Map XIV - 2-1

LOCATABLE AND LEASABLE NONENERGY MINERAL DEPOSITS IN THE CDCA



The values of many commodities fluctuate rapidly. Commodity values in the following reports are given in 1979 dollars, to provide a uniform baseline. Some values will have changed since that date. Data from each of the references used in the commodity reports were converted to 1979 dollars to facilitate comparison of different locations and commodities. This also allowed us to calculate the total production and total value of production for each commodity. The 1978 average dollar values of the commodities were taken from the Engineering and Mining Journal (February 1979). The geothermal values were given as relative potential for utilization, either for electrical generating or for nonelectrical uses. The oil and gas potentials were also relative. They were based on a geologic appraisal of the area, including examination of drill logs, and the sand and gravel values are based on their 1978 Federal royalty value, not sale value, of $0.25 per cubic yard from areas of known, past, and present extraction.

Mining districts or mineral deposits were circled on a series of acetate overlays. These overlays were prepared at a scale of 1:250,000. The quantity of each commodity, as a total of past production, known reserves, and resources is recorded next to the polygon. The polygon boundaries are conservatively drawn, reflecting the area distribution of known, measured, or reasonably inferred limits of deposit or district boundaries. Due to time limitations, no attempt has been made to predict undiscovered deposits. The need for such forecasting is obvious for economic and land management purposes.

All reserve measurements given in this report are demonstrated reserves. The resources are the combination of measured and indicated resources. Part 4 of this appendix contains a list of the definitions of units and reserves as used in this report.

COMMODITY GROUPS

Group I - Strategic Commodities

The United States needs strategic commodities to defend itself in times of war or national emergency. There is insufficient domestic production to fulfill our needs, and foreign supplies are vulnerable to disruption by adversaries. Strategic commodities found in the CDCA are shown in Table XIV-2-2 along with foreign sources and American dependence on the commodities as of March 31, 1979.

Table XIV-2-2 shows that, at present, only three commodities require stockpiling for defense purposes. The CDCA has produced all three commodities in the past and has excellent potential for future production of lead and zinc from sulphide, oxide, and carbonate ores and for future production of copper from porphyry-type copper deposits.

The CDCA was a major producer of silver, tungsten, and talc. Exploration, development, and production of GEM resources are now taking place in many parts of the CDCA. The CDCA is currently producing talc and is about to produce more silver. Large reserves of tungsten in the CDCA are currently being reexamined by industry for imminent mining. Kerr McGee is successfully producing tungsten from brine at a pilot plant at Searles Lake.

Table XIV-2-2
GROUP I COMMODITIES - STRATEGIC MINERALS

COMMODITY	Unit	Stock Goal	Inventory	Stock Short %	Import Reliance 1978 %	Import Reliance 1979 %	Foreign Source
Copper	Short Ton	1,299,000	24,717	98.1	20	13	Canada, Africa, South America
Lead	Short Ton	865,000	601,056	30.5	9	8	Canada, Australia, South America
Molybdenum	Pounds of Mo	0	0	0	Net Exp.		Canada, Chile
Silver	Troy Ounce	0	0	0	48	45	Canada, Mexico, Peru, England
Talc (Steatite)	Short Ton	104	1,092	0	Net Exp.		Italy, Canada, France
Thorium Nitrate	Pounds	1,800,000	7,156,996	0	NA		France, Canada, Netherl.
Tin	Long Ton	32,499	200,480	0	79	81	SE Asia, Bolivia
Tungsten	Pounds of W	8,823,000	96,405,162	0	56	59	Canada, Bolivia, Korea
Zinc	Short Ton	1,313,000	374,091	71.5	66	62	Canada, Central South America, Europe

One of three newly discovered molybdenum deposits may produce soon. The Ivanpah Mountains are favorable for skarn type tin. Thorium is present in rare earth deposits in the vicinity of Mountain Pass. Past, present, and future producers of strategic minerals in the CDCA are listed in Table XIV-2-3, based on known areas of mineralization.

It should be remembered that although the U.S. is presently short on only copper, lead, and zinc, in times of national crisis, other imported strategic commodities may have to come from domestic sources. If international supply lines are disrupted and stockpiles are drained, those commodities will be needed at once. The CDCA may be called upon to produce additional talc, tungsten, silver, lead, zinc, molybdenum, and copper.

Group II - Import Reliance of 50% or More

The three Group II commodities are, gold, potash and strontium. Domestic consumption is greater than the domestic production of these commodities by 50% or more. In 1979, the United States imported 100% of its strontium from Mexico and Spain; 56% of the gold consumed came mostly from Canada, South Africa, and the USSR; and 66% of the potash came from Canada and Israel.

The CDCA was once a major gold producer and is currently producing from several deposits. Large reserves and resources of strontium are known to exist within the CDCA, but present economic conditions make mining them impractical due to the lower cost of Mexican strontium. Potash is produced from large reserves contained in Searles Dry Lake. Future marketing conditions may change the situation for gold and strontium. Table XIV-2-4 lists known major deposits of gold, potash and strontium in the CDCA. With recently increased gold prices, many of these areas are being reevaluated by the mining industry for future production.

Group III - Minerals Exported to the World Market

Six Group III commodities (borates, lithium, rare earths, uranium, kyanite, and sodium carbonate (soda ash)) are produced in the United Stated in large exportable quantities. The United States produces more than 50 percent of the world supplies of borates, lithium, rare earths, and uranium. This allows us to maintain a commanding economic position in these four commodities.

The CDCA is the sole source of the U.S. borate supply and 95 percent of the domestic rare earth supply. Lithium was produced by Kerr McGee until 1978 from brines at Searles Lake. Formerly, small amounts of uranium were produced from the Coso area, the McCoy Mountains, and the eastern end of the Chocolate Mountains. Exploration activities are widespread in the CDCA. Soda ash is currently being produced by Kerr McGee. Its plant expanded by 40 percent in 1978 to process 1.3 million tons of soda ash per year. Kyanite was produced in Imperial County, and large resources are still present in the Cargo Muchacho Mountains.

Table XIV-2-5 displays the location and production history of the six commodities. Table XIV-2-6 shows the position of the six commodities in the 1978 world market.

Table XIV-2-3
PAST, CURRENT, AND FUTURE STRATEGIC MINERAL PRODUCERS IN THE CDCA

LOCATION	Cu	Pb	Mn	Mo	Ag	Talc	Th	Sn	W	Zn
Alexander Hills						PP				
Argus Range	FP	PP FP			PP FP					PP FP
Atolia-Red Mountain					PP FP					
Avawatz Mountains						PP				
Bullion Mountains		PP CL								
Calico Mountains		PP			PP FP					
Cargo Muchacho Mountains	PP FP									
Chocolate Mountains		PP			PP					
Darwin	PP FP				PP FP	PP			PP FP	PP FP
Eagle Mountains		PP FP			PP FP					
Funeral Mountains	FP									
Halloran					FP	CP				
Imperial County			PP FP							
Inyo Mountains	PP FP	PP FP			PP FP	PP CP				PP FP
Ivanpah-Clark Mountains	PP FP	PP FP			PP FP		PP FP	PP	PP FP	PP CP
Jacumba									PP FP	
Kingston Range		PP				PP CP				
Lane Mountain									PP	
Last Chance Mountains				FP						
Ludlow	PP FP		PP		PP					
Mojave					PP FP					
Music Valley							FP			

PP = Past Producer
CP = Current Producer
FP = Future Producer
CL = Closed

Cu = Copper
Pb = Lead
Mn = Manganese
Mo = Molybdenum

Ag = Silver
Th = Thorium
Sn = Tin
W = Tungsten

Zn = Zinc

Table XIV-2-3 (Continued)
PAST, CURRENT, AND FUTURE STRATEGIC MINERAL PRODUCERS IN THE CDCA

LOCATION	Cu	Pb	Mn	Mo	Ag	Talc	Th	Sn	W	Zn
New York Mountains		PP		FP						
Nopah Mountains	PP FP	PP FP			PP FP					PP FP
Old Woman Mountains	FP								PP	
Ord Mountains				FP						
Owlshead Mountains			PP FP							
Owens Peak									PP	
Panamint Mountains	FP	PP FP			PP FP CP					PP FP
Piute Mountains	PP									
Providence Mountains	PP	PP FP			PP FP					
Riverside County			PP FP							
Riverside Mountains	PP FP									
Rock Corral							FP			
Saddle Peak Hills						PP				
Salton Sea KGRA	FP	FP	FP		FP			FP		FP
Searles Lake									CP	
Shadow Mountains									PP	
Silurian Hills					PP CP	PP FP				
Slate Range	PP	PP			PP				PP	
Ubehebe	PP	PP								
Vontrigger Hills	PP									
Warm Springs Canyon	PP	PP			PP	PP CP FP				
Waterman Hills					PP FP					
Whipple Mountains	FP		PP							

Table XIV-2-4
50 PERCENT OR GREATER NET IMPORT RELIANCE

Location	Gold	Potash	Strontium
Alvord Mountains	PP		
Argus Range	PP CP		
Arica Mountains	PP		
Avawatz Mountains			FP
Bristol Lake			FP
Cargo Muchacho Mountains	PP FP		
Chocolate Mountains	PP FP		
Chuckwalla Mountains	PP		
Clark-Ivanpah Mountains	PP CP		FP
Darwin	PP FP		
Death Valley National Monument	PP		
Eagle Mountain	PP FP		
Fish Creek Mountains			PP FP
Fry Mountains	PP FP		
Halloran Springs	PP FP		
Inyo Mountains	PP FP		
Joshua Tree National Monument	PP Closed		
Laguna Dam	PP		
Lane Mountain	PP CP		
Ludlow	PP CP?		
Mirage Lake	PP CP?		

PP = Past Producer
CP = Current Producer
FP = Future Producer
CP? = Insufficient Data or Intermittent Producer

Table XIV-2-4 (Continued)
50 PERCENT OR GREATER NET IMPORT RELIANCE

Location	Gold	Potash	Strontium
Mud Hills			PP FP
New York Mountains	PP CP?		
Old Dad Mountain	PP FP		
Panamint Range	PP FP		
Providence Mountains	PP FP		
Picacho	PP FP		
Pinto Mountains	PP CP?		
Randsburg	PP FP	FP	
Riverside Mountains	PP FP		
Rosamond	PP CP?		
Sageland	PP FP		
San Bernardino Mountains	PP FP		
Shoshone	PP FP		
Slate Range	PP FP		
Stoddard Mountain	PP FP		

Table XIV-2-5
MAJOR EXPORT COMMODITIES IN THE CDCA

Location	Kyanite	Soda Ash	Lithium	Borates	Rare Earths	Uranium
Big Maria Mountains						FP?
Boron			FP?	CP		
Bristol Lake			FP			
Cadiz Lake			FP?			
Calico Mountains				PP FP		
Cargo Muchacho Mtns.	PP FP					
Chocolate Mountains						PP FP
Danby Lake			FP?			
Death Valley Jct.			FP?			
Death Valley Playa				PP		
Eureka Valley			FP?			
Furnace Creek Wash			FP?	CP		
Greenwater Range			FP?	PP FP		
Hector			FP?			
Kramer				FP		
McCoy Mountains						PP FP
Mountain Pass					CP	
Mud Hills						FP
Panamint Range						FP
Salton Sea KGRA			FP	FP		
Searles Lake		CP	PP FP	CP		
Shoshone				CP		
Soledad Mountain						FP
Tecopa			FP			FP

PP = Past Producer CP = Current Producer FP = Future Producer
? = Insufficient Data

Table XIV-2-6
WORLD MARKET RANKING OF MAJOR UNITED STATES EXPORT COMMODITIES

COMMODITY	Percent Exported (1979)	Percent of World Production	Dollar Values of Export 1978
Borates	293%	54%	126,630,000
Kyanite	42%	NA	19,000,000 [1]
Lithium	75%	80%	5,000,000
Rare Earths [2]	NA	51%	98,000
Soda Ash	13%	97%	47,519,000
Uranium	36%	NA	529,000,000

[1] Estimates

[2] Raw ore only, does not include finished products.

NA - Not Available

Group IV - Mineral Commodities of Local and Regional Economic Significance

Eight mineral commodities are of major economic significance to the local economy of southern California or to national, domestic economy. The locally important commodities are iron, sand and gravel, geothermal energy, gypsum, and limestone (Table XIV-2-7). These commodities support local industries that employ thousands of people in southern California, generate millions of dollars in wages and taxes, and support other industries (e.g., construction, agriculture, and chemical plants). The regionally important commodities are oil and gas, zeolites, and specialty clays (Table XIV-2-8). The significance of oil and gas is obvious. Zeolites and specialty clays are mined in the CDCA and are primarily marketed in the eastern United States where they are used in pollution control systems, chemical refining, ceramics, drill muds, and specialized chemical research.

In the "locally important" category, iron has been and is being mined in the CDCA. The iron feeds Kaiser Steel's Fontana plant and is used by the local cement industry in ferro-concrete manufacturing. Sand and gravel is mined in the CDCA and is used in concrete manufacturing, road construction, and irrigation drainage systems. Geothermal electrical energy is currently being produced at a rate of 23.5 megawatts (MWe) per hour in Imperial Valley. An additional 138 MWe of geothermal power are currently under development in this area. The CDCA has the capacity to produce 7500 MWe per hour, enough geothermal power by the year 2000 to supply most of the Los Angeles-San Diego region, lessening dependence on fossil fuels or nuclear plants. This is based on the recovery of 10 percent of the hot water in a reservoir. Gypsum is currently mined in the CDCA to produce wallboard for housing construction and calcium sulphate for agricultural purposes. Limestone is currently produced in the CDCA for the manufacture of cement, paint pigments, chemical reagents, and sulphur dioxide control units on fossil-fuel plants.

Of the "regionally important" commodities, oil and gas exploration has been active along the California, Nevada, and Arizona borders since the discovery of favorable geologic environments were found extending into this area from the Montana-Wyoming over-thrust belt. Oil exploration also occurs in the Antelope Valley near the San Bernardino Mountains. Natural gas exploration is occurring in the Coachella and Imperial valleys. Zeolites are being produced in the CDCA in the Death Valley Junction area, a major supplier of natural zeolite to the U.S. domestic market. Production may be increasing due to increased demands for pollution control and waste treatment systems. Quantities of specialty clays, mainly varieties of bentonite and ball (ceramic) clays, are now mined at four locations in the CDCA. These clays are primarily used for specialty ceramics, porcelains, cosmetics, and in drilling muds for the oil, gas, and geothermal industries. Based on projected demands, production of these regionally and locally important commodities should increase.

Table XIV-2-9 displays the mineral commodity groups in the CDCA and lists the in-place values (as a total of past production and reserves and resources), quantities (past production and reserves and resources), U.S. domestic market conditions relating to the mineral commodities, annual projected rate of increased demand, and the 1980 production status in the CDCA.

Table XIV-2-7
PRODUCTION OF MINERAL COMMODITIES OF LOCAL ECONOMIC SIGNIFICANCE IN THE CDCA

Location	Geothermal	Gypsum	Iron	Limestone	$NaSO_4$
Alvord Mountains				FP	
Amboy	FP?				
Argus Range			CP	CP	
Avawatz Mountains		FP	CP		
Baxter			CP	PP FP	
Big & Little Maria Mtns.		CP FP		FP	
Black Mountain				CP	
Brawley KGRA	CP				
Chubbuck				PP FP	
Clark Mountain		FP			
Coso KGRA	FP				
Coyote Mountains		FP		FP	
Darwin				FP?	
Desert Center	FP				
Desert Hot Springs	FP				
Dunes KGRA	FP				
Durmid					PP FP?
Eagle Mountain			CP		
East Brawley KGRA	FP				
East Mesa KGRA	CP				
Ford Dry Lake KGRA	FP				
Galway Lake			PP FP		
Gamble Spring Canyon				FP	
Glamis KGRA	FP				

PP = Past Producer
CP = Current Producer
FF = Future Producer
? = Insufficient Information

Table XIV-2-7 (Continued)
PRODUCTION OF MINERAL COMMODITIES OF LOCAL ECONOMIC SIGNIFICANCE IN THE CDCA

Location	Geothermal	Gypsum	Iron	Limestone	$NaSO_4$
Heber KGRA	CP				
Kelso Dunes			FP		
Kingston Mountains			CP		
Lee Flat				FP?	
Marble Mountains			PP FP	FP	
Mecca	FP				
Mojave				CP	
Ocotillo Wells	FP?				
Oro Grande				CP	
Palen Mountains		FP			
Pisgah Crater	FP?				
Piute Mountains				FP	
Providence Mountains			PP CP		
Randsburg KGRA	FP				
Riverside Mountains		FP?			
Rodman Mountains			PP FP		
Saline Valley (KGRA)	FP?				FP?
Salton City	FP?				
Salton Sea KGRA	CP		FP?		
Ship Mountains			PP FP		
Tecopa	FP				
Trona					CP
Twentynine Palms	FP				PP FP?
Westmoreland KGRA	FP				
Yuha Basin	FP				

Table XIV-2-8
PRODUCTION OF MINERAL COMMODITIES OF REGIONAL ECONOMIC SIGNIFICANCE IN THE CDCA

Deposits	Barite	Clays	Oil & Gas	Zeolites
Antelope Valley			FP	
Avawatz Mountains	FP?			
Barstow	PP FP			
Castle Mountains		CP		
Coachella Valley			FP	
Dead Mountains		FP		
Death Valley Junction		CP		
Fremont Valley			FP?	
Greenwater Range	FP?			
Hector		CP		FP
Landers Basin			FP?	
Lucerne Valley			FP?	
Milpitas Basin			FP?	
Mountain Pass	FP			
Mud Hills				FP
Olancha		PP FP		
Pahrump-Ivanpah Valley			FP	
Piute Valley			FP	
Salton Sea (east)			FP?	
Salton Sea KGRA	FP?			
Salton Sea (west)			FP	

PP = Past Producer
CP = Current Producer
FF = Future Producer
? = Insufficient Information

Table XIV-2-8 (Continued)
PRODUCTION OF MINERAL COMMODITIES OF REGIONAL ECONOMIC SIGNIFICANCE IN THE CDCA

Deposits	Barite	Clays	Oil & Gas	Zeolites
Shoshone (east)				FP
Shoshone (west)		PP FP		FP
Siluran Hills	FP?			
Tecopa		CP		
Victorville Basin			FP?	
Whipple Mountains	FP			
Yuha Basin			FP?	

REGIONAL ECONOMIC GEOLOGY OF THE CDCA

Precambrian (600 Million Years Ago or Older)

Mineral deposits are often associated with particular rock types or rocks of a specific age. A very brief discussion of the geology of the CDCA as it pertains to mineralization is given below. The geologic time chart (Figure XIV-1-12) shows the components of the geologic time scale used in this report.

The CDCA has undergone a long and complex geologic evolution since middle Precambrian. Exposed Precambrian rocks in the CDCA (Map XIV-2-2) are composed of igneous and metamorphic sites, which also contain large areas of metasedimentary gneisses and schists of uncertain depositional origin. Igneous rocks are represented by primary granitic rocks, anatectic (melting of older) gneisses and granites, and, in the East Mojave area, by carbonatite intrusives, especially at Mountain Pass.

Two elongated blocks of Precambrian rocks are present in the CDCA. The northern block enters the CDCA from Nevada and Arizona, trends northwestward, and is terminated by faulting in the Panamint Mountains. This northern belt appears to be an extension of the Precambrian mineral belt currently defined in northern Arizona and southern Nevada. A large proportion of the metallic and precious metal deposits in the CDCA are associated with this belt, as are the rare earth deposits (Map XIV-2-3).

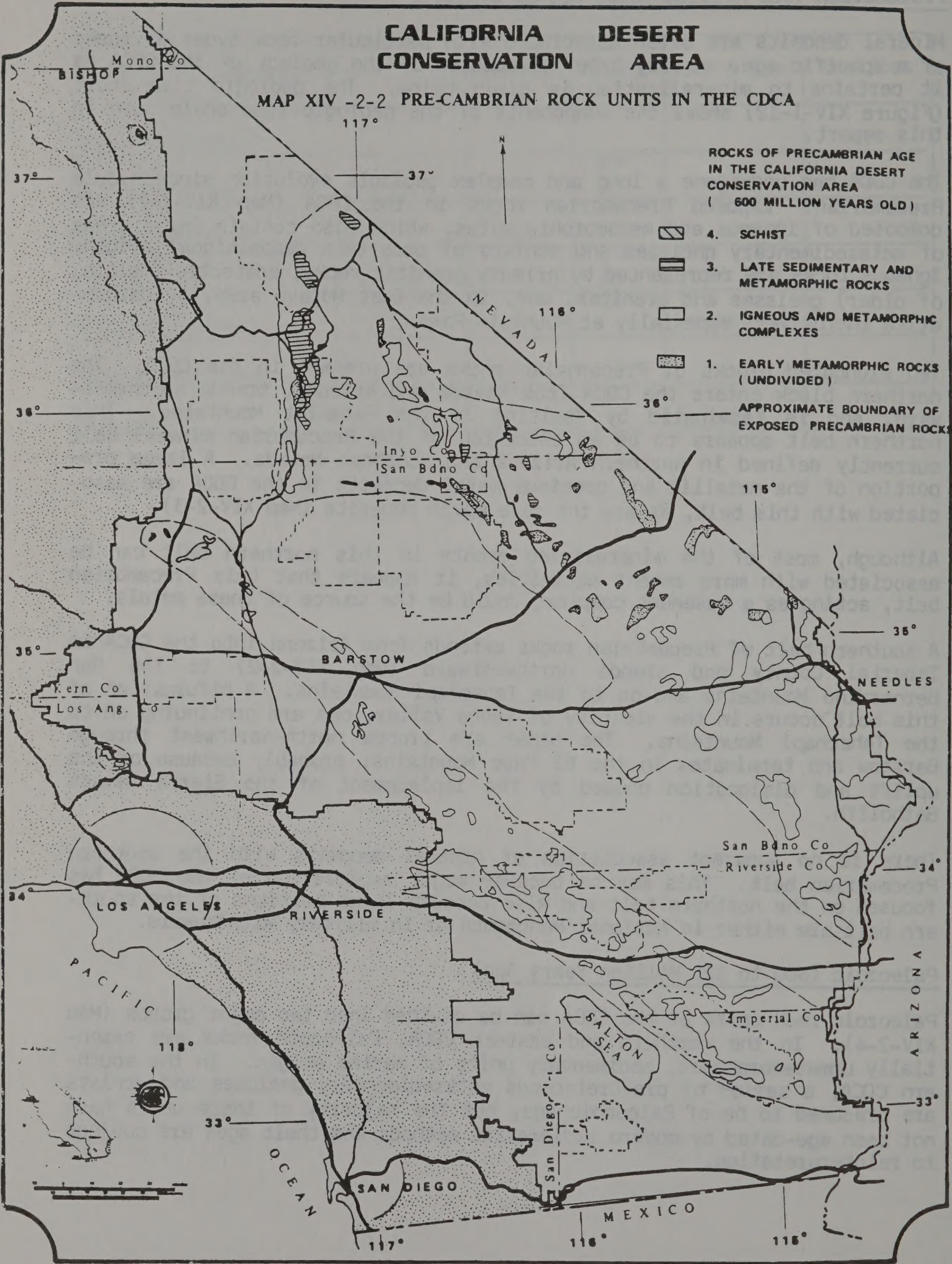
Although, most of the mineralizing events in this northern belt can be associated with more recent activities, it appears that this Precambrian belt, acting as a basement complex, could be the source of these metals.

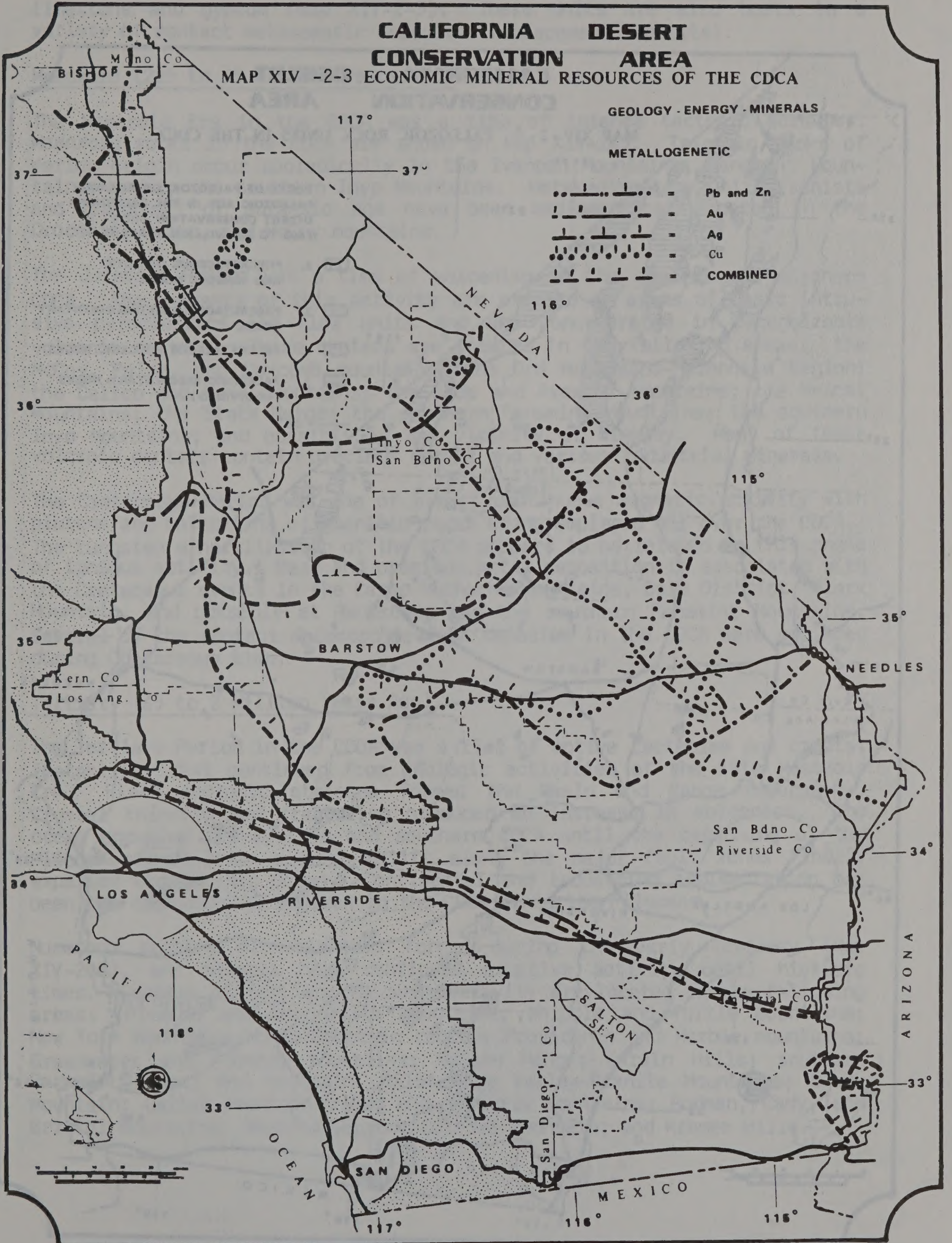
A southern belt of Precambrian rocks extends from Arizona into the CDCA in Imperial County and trends northwestward (Map XIV-2-2) to the San Bernardino Mountains and on to the Tehachapi Mountains. A bifurcation of this belt occurs in the vicinity of Yucca Valley, one arm continuing on to the Tehachapi Mountains. The other arm trends north-northwest through Barstow and terminates in the El Paso Mountains, probably because of the uplift and dislocation caused by the implacement of the Sierra Nevada Batholith.

There is no apparent association of mineral deposits with the southern Precambrian belt. This may be because major exploration of the CDCA has focused on the northern belt and also because large portions of the southern belt are either in National Monuments or in military withdrawals.

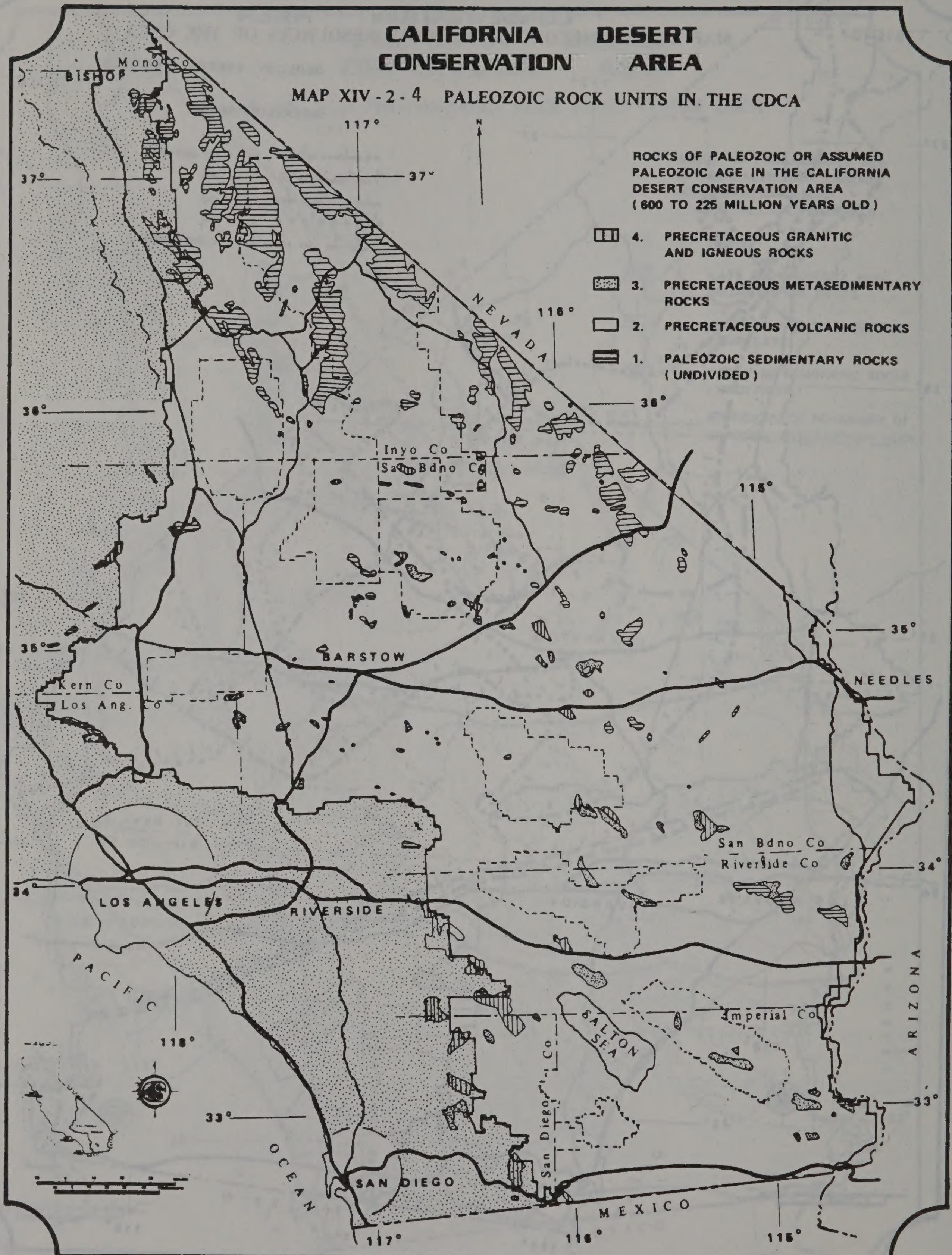
Paleozoic (600 to 225 Million Years Ago)

Paleozoic rock units of the CDCA can be divided into two major groups (Map XIV-2-4). In the northern and eastern CDCA, Paleozoic rocks are essentially unmetamorphosed, sedimentary units of marine origin. In the southern CDCA, a series of pre-Cretaceous metasedimentary gneisses and schists are presumed to be of Paleozoic age, but the majority of these units have not been age-dated by modern radiometric methods and their ages are subject to reinterpretation.


CALIFORNIA DESERT CONSERVATION AREA
MAP XIV -2-2 PRE-CAMBRIAN ROCK UNITS IN THE CDCA
ROCKS OF PRECAMBRIAN AGE IN THE CALIFORNIA DESERT CONSERVATION AREA (600 MILLION YEARS OLD)
4. SCHIST
3. LATE SEDIMENTARY AND METAMORPHIC ROCKS
2. IGNEOUS AND METAMORPHIC COMPLEXES
1. EARLY METAMORPHIC ROCKS (UNDIVIDED)
APPROXIMATE BOUNDARY OF EXPOSED PRECAMBRIAN ROCKS
N
117°
116°
115°
118°
37°
36°
35°
34°
33°
Mono
BISHOP
NEVADA
Inyo Co
San Bdno Co
BARSTOW
NEEDLES
Kern Co
Los Ang. Co
San Bdno Co
Riverside Co
LOS ANGELES
RIVERSIDE
PACIFIC
OCEAN
SALTON SEA
Imperial Co
San Diego Co
SAN DIEGO
MEXICO
ARIZONA



CALIFORNIA DESERT CONSERVATION AREA
MAP XIV -2-3 ECONOMIC MINERAL RESOURCES OF THE CDCA
GEOLOGY - ENERGY - MINERALS
METALLOGENETIC
= Pb and Zn
= Au
= Ag
= Cu
= COMBINED
BISHOP
Mono Co
117°
37°
116°
NEVADA
36°
Inyo Co
San Bdno Co
115°
35°
BARSTOW
NEEDLES
Kern Co
Los Ang. Co
San Bdno Co
Riverside Co
34°
LOS ANGELES
RIVERSIDE
PACIFIC
OCEAN
ARIZONA
SALTON SEA
118°
33°
San Diego Co
SAN DIEGO
MEXICO


CALIFORNIA DESERT CONSERVATION AREA
MAP XIV-2-4 PALEOZOIC ROCK UNITS IN THE CDCA
ROCKS OF PALEOZOIC OR ASSUMED PALEOZOIC AGE IN THE CALIFORNIA DESERT CONSERVATION AREA (600 TO 225 MILLION YEARS OLD)
4. PRECRETACEOUS GRANITIC AND IGNEOUS ROCKS
3. PRECRETACEOUS METASEDIMENTARY ROCKS
2. PRECRETACEOUS VOLCANIC ROCKS
1. PALEÓZOIC SEDIMENTARY ROCKS (UNDIVIDED)
BISHOP
Mono Co
NEVADA
Inyo Co
San Bdno Co
BARSTOW
NEEDLES
Kern Co
Los Ang. Co
LOS ANGELES
RIVERSIDE
San Bdno Co
Riverside Co
ARIZONA
PACIFIC
OCEAN
SALTON SEA
Imperial Co
San Diego Co
SAN DIEGO
MEXICO
117°
116°
115°
118°
37°
36°
35°
34°
33°
N

The Paleozoic units of the northern and eastern CDCA are major sources of limestone and gypsum (Map XIV-2-3). These units are also hosts to a variety of contact metasomatic deposits (replacement deposits).

Mesozoic (225 to 65 Million Years Ago)

The Mesozoic Era in the CDCA was a time of intense tectonic activity. Mesozoic rocks in the CDCA are shown on Map XIV-2-5. Triassic rocks of marine origin occur sporadically in the Ivanpah Mountains, Panamint Mountains, and in the southern Inyo Mountains. Metasedimentary units (schists and gneisses) of Jurassic age have been radiometrically dated in the Orocopia, Palen, and McCoy mountains.

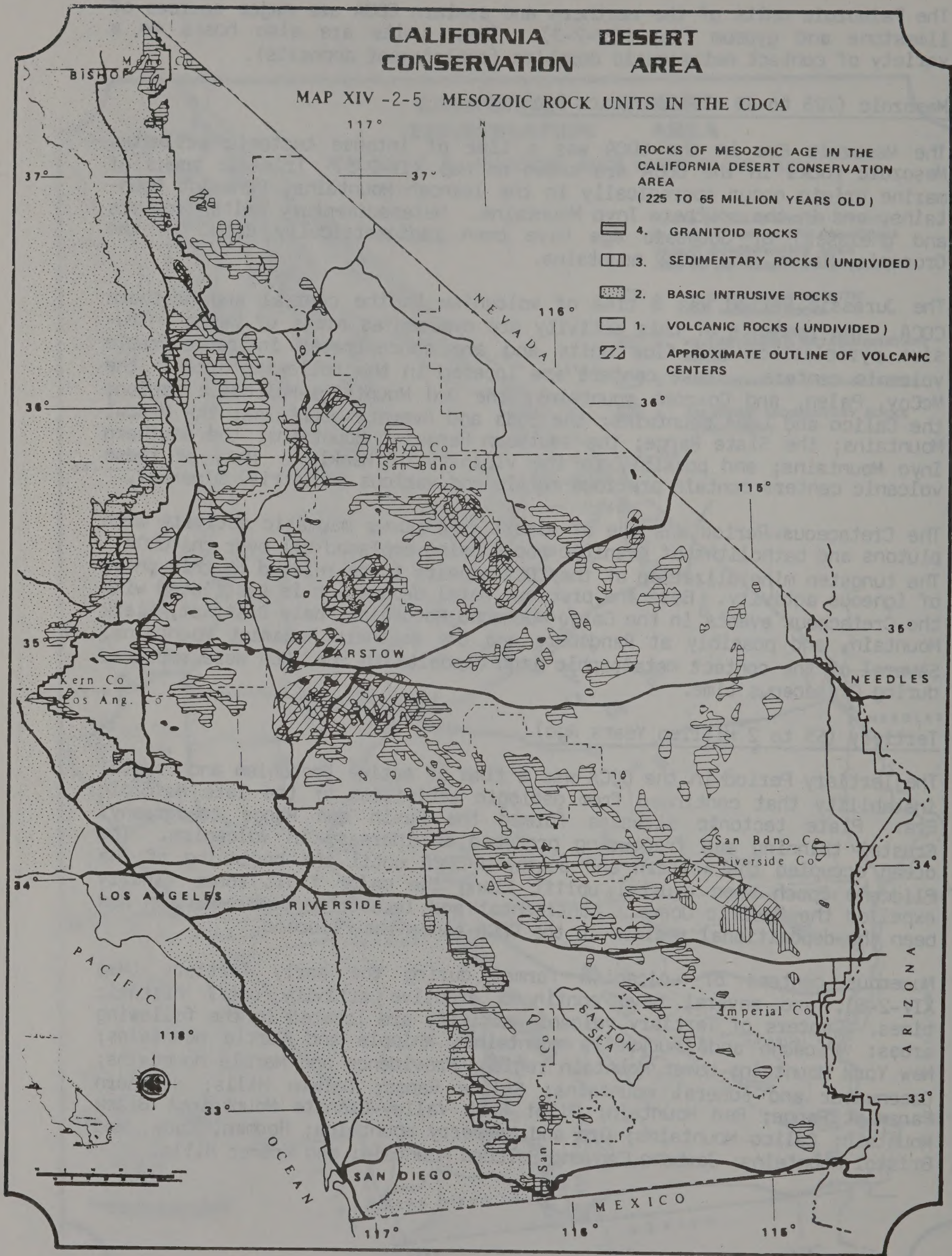
The Jurassic Period was a time of volcanism in the central and northern CDCA. The remnants of this activity are exposed as areas of basic intrusive pyroclastics and flow units and are concentrated in recognizable volcanic centers. These centers are located in the following areas: the McCoy, Palen, and Coxcomb mountains; the Ord Mountains-Helendale region; the Calico and Lane mountains; the Soda and Avawatz mountains; the Mescal Mountains; the Slate Range; the southern Panamint Mountains; the southern Inyo Mountains; and possibly in the vicinity of Hinkley. Many of these volcanic centers contain precious metals and various industrial minerals.

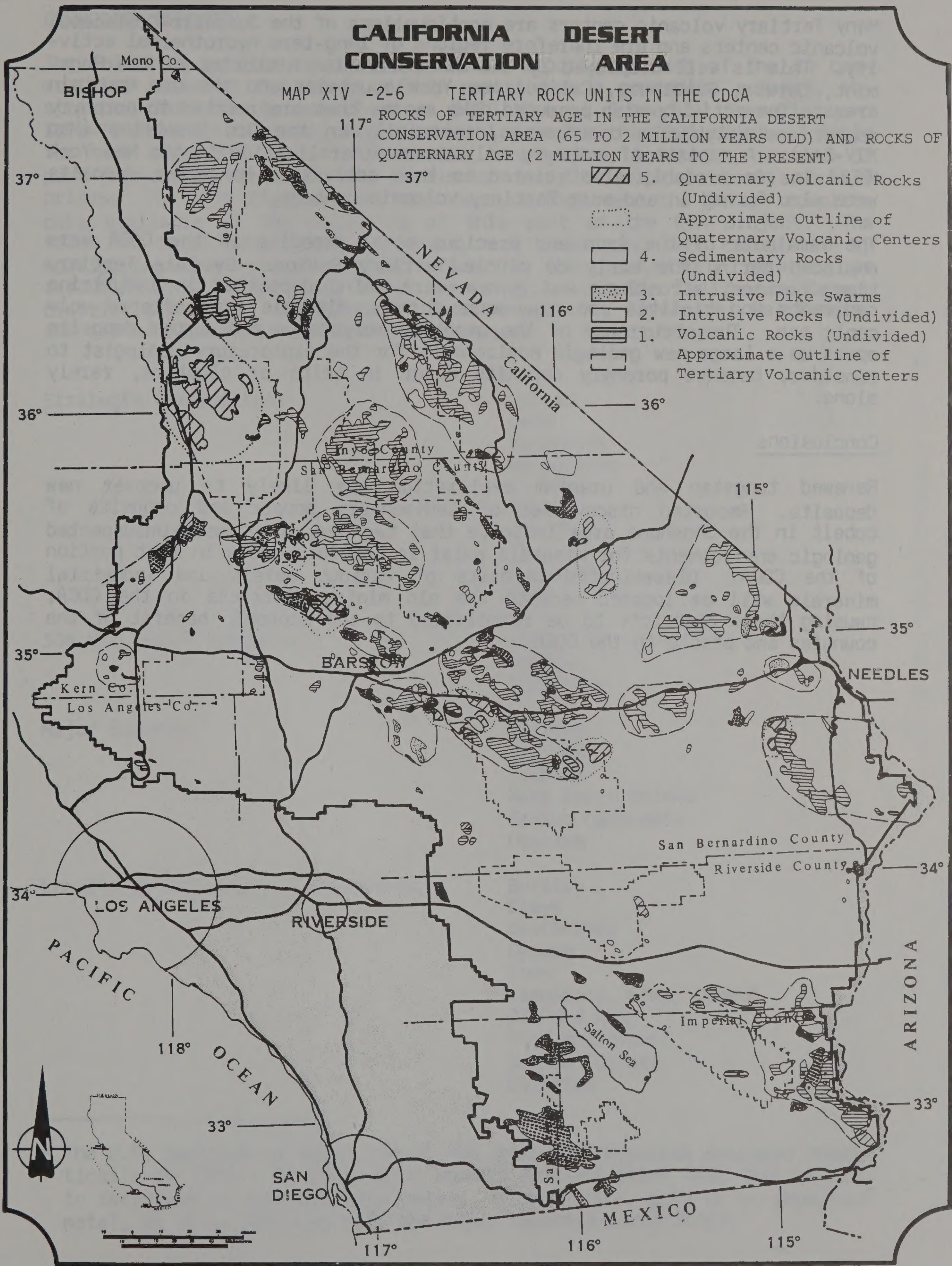
The Cretaceous Period was one of almost continuous magmatic activity with plutons and batholiths of granitic rocks being emplaced all over the CDCA. The tungsten mineralization of the CDCA appears to be related to this phase of igneous activity. Base and precious metal deposition is associated with the Cretaceous events in the Cargo Muchacho Mountains, Dale District, Clark Mountain, and possibly at Randsburg and the southern Panamint Mountains. Several of the contact metamorphic iron deposits in the CDCA were emplaced during Cretaceous time.

Tertiary (65 to 2 Million Years Ago)

The Tertiary Period in the CDCA was a time of active tectonism and crustal instability that continued from geologic activities of the late Mesozoic Era. Plate tectonic stresses formed the Basin and Range topography. Crustal thinning and fracturing produced an increase in volcanism. The ocean occupied the western and southern CDCA until the beginning of the Pliocene Epoch when crustal uplift along the major fault zones finally expelled the Pacific Ocean. Continental and lacustrine sedimentation has been the depositional regimen in the CDCA since the Pliocene.

Numerous centers of volcanism formed during the early Tertiary (Map XIV-2-6), and several have continued eruptive activity until historic times. Centers of Tertiary volcanic activity are located in the following areas: Picacho and Chuckwalla mountains; Whipple and Turtle mountains; New York Mountains-Homer Mountain region; Providence and Marble mountains; Greenwater and Funeral mountains; Saline Range; Darwin Hills; southern Panamint Range; Red Mountain; Pilot Knob Valley-Granite Mountains; Black Mountain; Calico Mountains; Ord and Newberry mountains; Rodman, Cady, and Bristol mountains; Jawbone Canyon; Soledad Mountain; and Kramer Hills.


CALIFORNIA DESERT CONSERVATION AREA
MAP XIV -2-5 MESOZOIC ROCK UNITS IN THE CDCA
ROCKS OF MESOZOIC AGE IN THE CALIFORNIA DESERT CONSERVATION AREA
(225 TO 65 MILLION YEARS OLD)
4. GRANITOID ROCKS
3. SEDIMENTARY ROCKS (UNDIVIDED)
2. BASIC INTRUSIVE ROCKS
1. VOLCANIC ROCKS (UNDIVIDED)
APPROXIMATE OUTLINE OF VOLCANIC CENTERS
BISHOP
NEVADA
Inyo Co
San Bdno Co
BARSTOW
NEEDLES
Kern Co
Los Ang. Co
San Bdno Co
Riverside Co
LOS ANGELES
RIVERSIDE
PACIFIC
OCEAN
SALTON SEA
Imperial Co
San Diego Co
SAN DIEGO
MEXICO
ARIZONA
117°
116°
115°
118°
37°
36°
35°
34°
33°


CALIFORNIA DESERT
CONSERVATION AREA
MAP XIV -2-6 TERTIARY ROCK UNITS IN THE CDCA
ROCKS OF TERTIARY AGE IN THE CALIFORNIA DESERT CONSERVATION AREA (65 TO 2 MILLION YEARS OLD) AND ROCKS OF QUATERNARY AGE (2 MILLION YEARS TO THE PRESENT)
5. Quaternary Volcanic Rocks (Undivided)
Approximate Outline of Quaternary Volcanic Centers
4. Sedimentary Rocks (Undivided)
3. Intrusive Dike Swarms
2. Intrusive Rocks (Undivided)
1. Volcanic Rocks (Undivided)
Approximate Outline of Tertiary Volcanic Centers
Mono Co.
BISHOP
NEVADA
California
Inyo County
San Bernardino County
BARSTOW
NEEDLES
Kern Co.
Los Angeles Co.
San Bernardino County
Riverside County
LOS ANGELES
RIVERSIDE
PACIFIC OCEAN
Salton Sea
Imperial
ARIZONA
SAN DIEGO
MEXICO
37°
36°
35°
34°
33°
118°
117°
116°
115°

Many Tertiary volcanic centers are continuations of the Jurassic-Cretaceous volcanic centers and are therefore regions of long-term hydrothermal activity. This is well displayed by the mineralization histories of the Panamint, Darwin, Randsburg, Calico, New York mountains and the Ord Mountain areas. The activity also produced dike swarms that are related to porphyry copper and molybdenum occurrences, especially in the Ord Mountains (Map XIV-2-3). A deposit of porphyry molybdenum mineralization in the New York Mountains is probably also related to this activity. Manganese deposits were also formed in and near Tertiary volcanic centers.

The remainder of the iron and precious metal deposits in the CDCA were emplaced during the early to middle Tertiary Period. By late Tertiary time, borates, strontium, and gypsum were being deposited in lacustrine sediments and zeolites and clay were forming minerals from altered volcanic ash. The occurrence of the prophyry molybdenum and copper deposits opens up a large new geologic environment for the exploratory geologist to consider, because porphyry deposits occur in belts or clusters, rarely alone.

Conclusions

Renewed tungsten and uranium exploration are likely to uncover new deposits. Reported discoveries of sedimentary copper and deposits of cobalt in the Shoshone area indicate that two new, previously unsuspected geologic environments for minerals exist in Tertiary rocks in that portion of the CDCA. Disseminated deposits of various metals and industrial minerals will be located beneath the old mining districts in the CDCA, causing these districts to be reactivated to the economic benefit of the counties and people in the CDCA.

COMMODITY REPORTS

The following section contains individual reports on each of the 25 commodities selected for study. Each report has a commodity summary, abstracted from the Bureau of Mines 1980 Mineral Commodity Summaries and 1978-79 Minerals Yearbook, with pertinent data for the CDCA added. A table for each commodity lists the deposits inventoried, locations, amounts of past production, reserves and resources, and the value in terms of 1979 prices. The 1979 figures were used because they were the latest complete data available at the beginning of this part of the GEM project. The value of total production, reserves, and resources, was calculated by multiplying the commodity unit price by the production, reserve, or resource total. All data used are on file at the California Desert District Office of the Bureau of Land Management, Riverside, California, and are available for inspection upon request at that office.

Strategic Commodities:	Copper Lead Manganese Molybdenum Silver Talc Thorium Tin Tungsten Zinc
50% Net Import Reliance:*	Gold Potash Strontium
Major Exports:	Borates Kyanite Lithium Rare Earth Oxides Sodium Carbonate Uranium
Locally or Regionally Significant:	Barite Clays Geothermal Gypsum Iron Limestone, Lime, Cement Oil and Gas Sand and Gravel Sodium Sulfate Zeolites

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* The U.S. imported at least 50% of the gold and strontium consumed domestically in 1979. In 1980, gold imports dropped below 50%, due in part to recycling of this precious metal. Historically, gold is an important metal, so it is included with the major imported commodities.

Group I - Strategic Mineral Commodities

Copper (Cu)

Uses: The major uses of copper metal are: electrical 58%, construction 18%, industrial machinery 9%, transportation 9%, and other 6%.

Consumption: In 1979, the apparent U.S. consumption of copper was 2,350,000 metric tons of copper metal, both from primary mining and secondary recycling of copper scrap. The U.S. imported 328,323 metric tons of unmanufactured copper in 1979.

Trends: The consumption of copper is expected to be constant through 1985.

Production: U.S. mining production in 1979 was 1,443,556 metric tons of primary copper; recycling of scrap produced an additional 604,301 metric tons of copper metal.

Copper production in the U.S. came mainly from five states: Arizona 65%, Utah 13%, New Mexico 12%, Montana 5%, and Michigan 3%.

Copper has been an important commodity in the California Desert. The CDCA has produced copper metal as a by-product of gold, silver, and lead mining. The Ivanpah Mountains, Cerro Gordo, Bagdad-Chase Mine, Darwin District, Tecopa Mine and Santa Rosa Mine were centers of this mining activity. A few mines in the CDCA were primarily copper producers. Several areas of large tonnage, low-grade copper deposits have been inferred or located in the past five years in the CDCA. These are at Clark Mountain, Copper Basin, the Ord Mountains, and the Argus Mountains. Further exploration and development are anticipated.

The CDCA contains approximately 24,293,270 short tons of copper reserves and 14,000,000 short tons of copper resources. Areas that formerly produced copper have an excellent potential for future production according to geologic comparisons with similar districts in Montana, Arizona, Nevada, and Utah.

Substitutes: In many applications, there are subsititutes for copper. Materials such as aluminum, steel, and plastics can replace copper in electrical uses, shell casings, and plumbing, respectively.

Price: 1979 - $0.933 per pound, weighted average.

References: 13, 54, 55.

COPPER IN THE CDCA

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production* (lbs.)	Reserves[1] Resources[2] (lbs.)	Value ($ X 10^6)	Reference Number
148	American Eagle	Savahia Peak	Whipple Mtns.	122,194		.114	27
"	" "	" "	" "		6,840,000[1]	6.382	27
137	Bagdad-Chase	Ludlow	Cady Mtns.	4,368,000		4.075	112
150	Bendigo District	Riverside Mtns.	Riverside Mtns.	100,000+		.093	27
160	Black Eagle	Eagle Mtns.	Eagle Mtns.	114,424		.107	76
149a	Blue Cloud	Whipple Mtns.	Whipple Mtns.		2,256,000[2]	2.105	74a
107	C & K	Providence Mtns.	Providence Mtns.	100,000+		.093	27
166	Cargo Muchacho	Cargo Muchacho Mtns.	Picacho	312,000		.291	62
14	Cerro Gordo District	Inyo Mtns.	Talc City Hills	582,340		.543	53
149a	Copper Basin	Copper Basin	Whipple Mtns.		134,973,200[1]	125.930	21
43	Copper Queen	Slate Range	Darwin/Slate Range	100,000+		.093	27
91	Copper World	Clark Mountain	Clark Mountain	5,321,184		4.965	41, 107
18	Darwin District	Darwin	Darwin/Slate Range	1,489,396		1.390	37
25	Echo Canyon	Death Valley	DVNM: Funeral Mtns.		3,955,950[1]	3.691	30
21	Modoc District	Argus Range	Darwin/Slate Range	189,066		.176	38
92	Mohawk	Mountain Pass	Clark Mountain	203,456		.190	41
95	New Trail	Ivanpah Mtns.	Clark Mountain	148,778		.139	41, 113
36	Panamint District	Panamint	Panamint		14,000,000[2]	13.062	108
104	Piute	Goffs	Piute Mtns.	100,000+		.093	27
34	Queen of Sheba	Death Valley	DVNM: Confidence Hills	146,000		.136	61
119	Red Hill**	Ord Mountain	Ord Mountain		770,000,000[2]	718.410	21
160	Salton Sea KGRA	Niland	Salton Sea		60,000,000[2]	55.980	111
13	Santa Rosa	Darwin	Talc City Hills	487,000		.454	52
79	Shoshone Mines	Shoshone	Resting Spring Rng.	100,000+		.093	27
97	Standard	Ivanpah Mtns.	Clark Mountain	100,000+		.093	27
7	Ubehebe District	The Racetrack	DVNM: Cottonwood Mtns.	100,000+		.093	27
102	Vontrigger	Vontrigger Hills	Homer Mountain	444,449		.415	41
	Total Production			14,628,287		13.648	
	Total Reserves				145,769,150	136.003	
	Total Resources				846,256,000	789.556	

*Copper producers of over 100,000 lbs., there are numerous smaller producers not listed.
**Estimate based on preliminary data and subject to revision.

Lead (Pb)

Uses:	Batteries 61%, gasoline additives 12%, paints 6%, ammunition 4%, construction 3%, electrical 2%, and other 12%.
Consumption:	The U.S. consumed 1,358,355 metric tons of lead in 1979. The U.S. imported 240,023 metric tons of lead that year.
Trends:	From a 1976 base year, the domestic demand for lead is expected to increase at an annual rate of 1.8%.
Production:	The U.S. produced 1,905,144 metric tons of lead in 1979 from both primary and secondary (recycled) sources. Exports of lead, excluding scrap, totalled 43,543 metric tons. Fifteen mines produced 99% of the domestic production. Missouri produced 89%, Idaho 9%, Colorado 1%, and other states 1% of the 1979 domestic production. Historically, the CDCA has produced lead from the Darwin District, Ivanpah-Clark Mountains, Providence Mountains, Cerro Gordo District, Shoshone District, Santa Rosa Mines, and other areas. Production came from lead-zinc-silver ores. As the reevaluation of these mines and districts continues, future production of silver will also lead to extraction of lead and zinc in some places. Past production yielded 351,561,669 pounds from the CDCA. The renewed interest in silver deposits in the CDCA will probably result in more lead production in the future.
Substitutes:	Plastics can be substituted for lead in buildings, cable coverings, and in cans and containers. Lead competes with zinc-nickel, zinc-chlorine, and lithium-sulphur compounds in batteries.
Price:	1979 - $0.5264 per pound, average for common lead nationwide.
References:	54, 55, 73.

LEAD IN THE CDCA

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production* (lbs.)	Reserves[1] Resources[2] (lbs.)	Value ($ X 10^6)	Reference Number
22	Argus-Sterling	Argus Range	China Lake	100,000+		.053	35
33	Ashford	Death Valley	DVNM: Black Mtns.	100,000+		.053	35
11	Big Four	Panamint Range	Talc City Hills	155,872		.082	38
160	Black Eagle	Eagle Mountain	Eagle Mountain	1,480,914		.780	76
64	Burcham	Calico	Calico Mtns.	100,000+		.053	35
125	Carbonate	Oro Grande	Stoddard	100,000+		.053	35
14	Cerro Gordo District	Inyo Mtns.	Talc City Hills	77,467,000		40.779	53
43	Copper Queen	Slate Range	Darwin-Slate Range	1,331,440+		.701	95
91	Copper World	Clark Mountain	Clark Mountain	1,000,000+		.526	35
18	Darwin District	Darwin	Darwin-Slate Range	117,566,900		61.887	36
38	Honolulu-Big Horn	South Park Canyon	Panamint Range	350,000		.184	64
97	Ivanpah Mtns.	Ivanpah Mtns.	Clark Mountain	374,000		.197	41, 113
33	Jubilee Mine	Death Valley	DVNM: Black Mtns.	1,000,000		5.264	21
15	Keeler	Inyo Mtns.	Talc City Hills	100,000+		.053	35
10	Le Moigne	Panamint Range	DVNM: Tucki Mtn.	372,827		.196	38
21	Modoc District	Argus Range	Darwin-Slate Range	20,200,000		10.633	38, 91
92	Mohawk	Mountain Pass	Clark Mountain	3,125,105		1.645	41
3	Monster	Inyo Mtns.	Inyo Mtns.	100,000+		.053	
43	Ophir	Slate Range	Darwin-Slate Range	320,080+		.169	84
36	Panamint District	Happy Canyon	Panamint Range		14,000,000[2]	7.364	108
163	Paymaster	Chocolate Mtns.	Palo Verde Mtns.	2,500,000		1.316	62, 35
34	Queen of Sheba	Death Valley	DVNM: Confidence Hills	5,000,000		2.632	61
100	Sagamore	New York Mtns.	New York Mtns.	236,659		.125	41
160	Salton Sea KGRA	Niland	Salton Sea		900,000,000[2]	473.400	111
13	Santa Rosa	Darwin	Talc City Hills	11,990,792		6.311	52
79	Shoshone Mines	Shoshone	Resting Spr. Rng.	105,000,000		55.272	35
83	Silver Rule	Kingston Range	Kingston Range	230,000		.121	41
7	Ubehebe District	The Racetrack	DVNM: Cottonwood Mtns.	1,840,000+		.969	35, 64
136	War Eagle	Bullion Mtns.	MCAGCC-Bullion Mtns.	100,000+		.053	35
20	Zinc Hill	Darwin	Darwin-Slate Range	270,000		.142	36
	Total Production			352,511,589		185.562	
	Total Resources				914,000,000	481.130	

*Lead producers over 100,000 lbs., there are numerous smaller producers not listed.

Manganese (Mn)

Uses: Transportation 23%, construction 20%, machinery 15%, and other 42%. Most manganese is converted to ferromanganese for use in the steel industry.

Consumption: During 1979, the U.S. consumed 1,372,190 short tons of manganese ore, including 499,782 short tons of imported ore.

Trends: The U.S. demand for manganese is expected to increase by 1.6% annually through 1985. Most of this demand will be met by imports.

Production: No higher grade (greater than or equal to 35% Mn) ore has been produced in the U.S. in the past four years. Lower grade manganese ore has been produced in Minnesota, New Mexico, and South Carolina during this time. Manganese was produced from mines in eastern Riverside County and northern Imperial County, as well as other smaller deposits in the CDCA.

The U.S. Bureau of Mines estimates that there are about 74,000,000 short tons of domestic, low grade manganese resources in Arizona, Arkansas, Colorado, Maine, and Minnesota. These resources contain less than 35% manganese. California mines have produced manganese only with the aid of price supports. There is manganese of unknown grade and tonnage remaining in formerly active deposits in the CDCA. These mines could become active again with financial incentives.

Substitutes: There are no satisfactory substitutes for the major uses of manganese.

Price: 1979 - $1.40 per long ton unit, ore containing 48% Mn, c.i.f. U.S. ports. This is a representative price. Actual prices are negotiated based on many factors.

References: 22, 54, 55.

MANGANESE IN THE CDCA

Map -XIV-2-1 No.	Deposit	Location	GRA	Production (long tons)	Reserves[1] Resources[2] (long tons)	Value ($ X 10^6)	Reference Number
161,162	Imperial County	North Imperial Co.	Picacho and Palo Verde Mtns.	1,708,320		239.165	62, 21
114	Ludlow	Ludlow	Cady Mtns.	770		.108	92
70	Owlshead	Owlshead Spring	Owlshead Mtns.	3,839		.537	92
153	Riverside County	East-Central Riverside County	Big Maria Mtns. & Palen/McCoy Mtns.	22,321		3.125	76, 21
160	Salton Sea KGRA	Niland	Salton Sea		6,250,000[2]	875.000	111
149	Whipple Mtns.	Whipple Mtns.	Whipple Mtns.	1,750		.245	92
	Total Production			1,737,000		243.180	
	Total Resources				6,250,000	875.000	

Molybdenum (Mo)

Uses: 70% of molybdenum is used as a steel-hardening agent. Of the remaining 30%, the usage is: other metallurgical applications 22%; catalysts, lubricants, and chemicals 8%.

Consumption: During 1980, the apparent U.S. consumption of molybdenum was 60,800,000 pounds of molybdenum metal. That year the U.S. exported 68,217,000 pounds of molybdenum metal.

Trends: From a 1978 base, demand for molybdenum will increase annually at a rate of 4.2% through 1990. However, between 1977 and 1978 demand increased 12%. Demand decreased slightly in 1979 and 1980.

Production: In 1980, the U.S. mined 150,686,000 pounds of molybdenum metal. Major mines are located in Colorado, New Mexico, and Arizona. A new mine in Nevada will be in operation by 1981.

Three potentially large, possibly economic molybdenum deposits in the CDCA are being explored by major mining companies. Molybdenum deposits cluster in "belts," so the potential for future deposits in the same areas is high.

Substitutes: There is no substitute for molybdenum in alloying of metals. It is a hardening agent in tool and machine steels, and molybdenum sulphide (MoS) is a dry lubricant.

Price: 1979 - $7.50 per pound, Climax molybdenum oxide.

References: 46, 54, 55.

MOLYBDENUM IN THE CDCA*

Map -XIV-2-1 No.	Deposit	Location	GRA	Production (lbs.)	Reserves[1] Resources[2] (lbs.)	Value ($ X 10^6)	Reference Number
101	Big Hunch	New York Mtns.	New York Mtns.		800,000,000[2]	6,000.000	21
119	Red Hill	Ord Mountain	Ord Mountain		770,000,000[2]	5,775.000	21
1	State Line Deposit	Last Chance Range	Last Chance Range		500,000,000[2]	3,750.000	21
	Total Resources				2,070,000,000	15,525.000	

*Estimates based on preliminary data and subject to revision.

Silver (Ag)

Uses: Photography 39%, electrical and electronic components 25%, sterlingware and electroplated-ware 15%, brazing alloys and solders 8%, and other 13%.

Consumption: The U.S. consumed 157,426,000 troy ounces of silver in 1979. Imports amounted to 92,381,000 troy ounces. Domestic mine production was equivalent to 65% of total production.

Trends: From a 1976 base year, domestic consumption of silver is expected to increase at an annual rate of 2.5% through 1985.

Production: The U.S. produced 38,055,000 troy ounces in 1979. Approximately 49% of the silver was recovered as a byproduct of copper and lead-zinc mining. Domestic production in 1979 was as follows: Idaho 46%; Arizona 30%; Colorado, Utah, Montana, Missouri, and others 24%. California produced 64,185 troy ounces, or 0.17% of U.S. production.

Silver mining in the CDCA has historically been a major activity. Currently, two mines are active, one in the Silurian Hills, and the other at Panamint City. Several in the Providence, Calico, and Inyo Mountains are being reactivated because of recent increases in the price of silver.

The CDCA contains approximately 175,400,000 troy ounces of silver reserves.

Substitutes: Aluminum and rhodium can substitute for silver in reflective materials, like mirrors. Tantalum replaces silver in surgical plates, pins, and sutures. Stainless steel tableware has become more common than silverware.

Price: 1979 - $11.109 per troy ounce, average.

References: 54, 55, 79.

SILVER IN THE CDCA

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production* (Troy oz.)	Reserves[1] Resources[2] (Troy oz.)	Value (\$ X 10^6)	Reference Number
137	Bagdad Chase	Ludlow	Cady Mtns.	180,000		2.000	113
160	Black Eagle	Eagle Mtns.	Eagle Mtns.	114,768		1.275	76
106	Bonanza King	Providence Mtns.	Providence Mtns.	1,554,878		17.273	107
64	Calico District	Calico	Calico	1,828,690		20.315	112
	" "	"	"		190,000,000[1]	2,110.710	90,2,62a
14	Cerro Gordo District	Inyo Mtns.	Talc City Hills	4,581,937		50.901	53
43	Copper Queen	Slate Range	Darwin/Slate Range	64,389+		0.715	95
91	Copper World	Clark Mountain	Clark Mountain	60,778		0.675	41
18	Darwin District	Darwin	Darwin/Slate Range	7,630,497		84.767	36
89	Ivanpah District	Clark Mountain	Clark Mountain	10,894,182		121.024	41
50	Kelly Mine	Red Mountain	Randsburg	20,376,000		226.357	96, 99
	" "	" "	"		160,000[1]	1.777	34
21	Modoc District	Argus Range	Darwin/Slate Range	2,037,888		22.639	38, 91
92	Mohawk	Mountain Pass	Clark Mountain	92,772		1.030	41
55	Mojave District	Rosamond	Soledad/Rosamond	3,766,700		41.772	4, 97,101
36	Panamint District	Panamint	Panamint	1,717,687		19.082	108
	" "	"	"		17,600,000[2]	195.518	108
163	Paymaster	Chocolate Mtns.	Palo Verde Range	175,000		1.944	62
34	Queen of Sheba	Death Valley	DVNM: Confidence Hills	100,000		1.111	61
84	Riggs	Silver Lake	Halloran	200,000		2.222	112
160	Salton Sea KGRA	Niland	Salton Sea		120,000,000[2]	1,333.080	111
13	Santa Rosa	Darwin	Talc City Hills	426,534		4.738	52
79	Shoshone Mines	Shoshone	Resting Spr. Range	950,000		10.554	35
9	Skidoo District	Death Valley	DVNM: Tucki Mtn.		158,650[1]	1.762	31
87	Telegraph	Halloran Springs	Cima Dome		83,520[1]	0.928	67
63	Waterman	Barstow	Calico	1,593,252		17.699	112
	Total Production			58,345,952		648.165	
	Total Reserves				190,402,170	2,115.178	
	Total Resources				137,600,000	1,528.598	

*Silver producers of over 50,000 ounces; there are numerous smaller producers not listed.

Talc ($H_2Mg_3(SiO_3)_4$)

Uses: Talc is used domestically in the manufacture of ceramics 28%, paints 21%, plastics 16%, cosmetics 8%, paper 9%, rubber 4%, roofing 2%, and other 12%.

Consumption: In 1979, the apparent U.S. consumption of talc was 1,020,000 short tons of talc.

Trends: From a 1977 base year, U.S. talc consumption will increase at an annual rate of 4% through 1985. Export shipments will increase at an annual rate of about 10% through 1985.

Production: Total U.S. production in 1979 was 1,453,000 short tons, of which 316,000 short tons (22%) were exported. The annual production figures in the CDCA are not known but would be approximately 10,000 to 20,000 short tons.

Twelve states, including California, are talc producers. More than 90% of domestic production comes from Vermont, Montana, New York, and Texas. Now, most California talc comes from Inyo County. Production in the CDCA comes from the Darwin and Tecopa areas of Inyo County and the Silurian Hills of San Bernardino County.

The CDCA has been a source of talc since the 1920s, and production will continue in the future. Talc reserves and resources are present in the CDCA, though tonnage figures are not known or are not available.

Substitutes: Talc competes with kaolin, fuller's earth and other inorganic materials as fillers. It competes with feldspar in ceramic uses and mica in plastics.

Price: 1979 - $69.50 per short ton fob (California, fractionated talc) to $119.00 per short ton (California Hegman No. 4-5, paint-grade talc).

References: 20, 54, 55.

TALC IN THE CDCA

Map -XIV-2-1 No.	Deposit	Location	GRA	Production (Short Tons)	Reserves[1] Resources[2] (Short Tons)	Value ($ X 10^6)	Reference Number
80	Alexander Hills	Alexander Hills	Dumont Dunes	346,050		24.051	115
35	Death Valley	Death Valley	DVNM: Confidence	609,171		42.337	115
	National Monument		Hills		1,084,000[1]	75.338	30
"	"	"	"		3,009,000[2]	209.126	30
71	Ibex Hills	Ibex Hills	Dumont Dunes	217,780		15.136	115
81	Kingston Range	Kingston Range	Kingston Range	93,500		6.498	115
4	North Inyo Mtns.	Inyo Mtns.	Inyo Mtns.	30,000		2.085	68
68	Sheep Creek Springs	Sheep Creek Springs	Avawatz Mtns.	20,000		1.390	115
72	Saddle Peak Hills	Saddle Peak Hills	Dumont Dunes	20,700		1.439	115
84	Siluran Hills	Siluran Hills	Halloran	5,000		0.348	115
85	Silver Lake	Silver Lake	Halloran	230,000		15.985	114
19	Talc City Hills	Talc City Hills	Talc City Hills	280,000		19.460	68, 36
86	Yucca Grove	Halloran Springs	Halloran	50,000		3.475	113
	"	"	"		15,000[1]	1.043	25a
	Total Production			1,882,201		130.813	
	Total Reserves				1,099,000	76.381	
	Total Resources				3,009,000	209.126	

Thorium (ThO_2)

Uses: Electrical generation in nuclear reactors, mantles in incandescent lamps, magnesium-thorium alloys, and in refractories.

Consumption: The U.S. consumed 36 short tons of thorium in 1979, of which 6 short tons went into nuclear reactors (breeder type reactors) and 10 short tons were used in refractories. Most of these requirements are met by imported thorium ore or processed thorium.

Trends: Using 1977 as a base year, an annual rate of increase of 1% through 1985 is forecast.

Production: Two operations in the U.S., both in Florida, recover monazite, a thorium ore, from sedimentary deposits. Thorium is mined with the rare earths at Mountain Pass in the CDCA, but it is not being recovered at this time.

Substitutes: There are no substitutes for the nonenergy uses of thorium. Uranium and thorium are used in breeder reactors.

Prices: 1979 - $240.00 per short ton, average declared value of imported monzonite. $11.79 per pound, 99.99% pure thorium oxide.

References: 54, 55, 85.

THORIUM IN THE CDCA

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production (lbs.)	Reserves[1] Resources[2] (lbs.)	Value ($ X 10^6)	Reference Number
93	Mountain Pass	Mountain Pass	Clark Mountain		302,400[1]	3.565	85
	" "	" "	" "		300,000[2]	3.537	85
131	Music Valley	Twentynine Palms	Dale Lake		Potential Resource		93, 28
121	Rock Corral	Rock Corral	Big Horn Mtns.		Potential Resource		93
	Total Reserves				302,400	3.565	
	Total Resources				300,000	3.537	

Tin (Sn)

Uses: Cans and containers 31%, electrical 15%, construction 15%, transportation 12%, and other 27%.

Consumption: Total domestic consumption in 1979 was 62,465 metric tons of tin metal, of which 81% was imported.

Trends: From a 1976 base year, the demand for tin is expected to increase at an annual rate of 1% through 1985.

Production: The U.S. produced small amounts of tin as a byproduct of molybdenum mining at Climax, Colorado, from a placer deposit in Mew Mexico, and from exploration activities in Alaska. Domestic production was less than 200 metric tons of tin metal in 1979. Three areas in California (Gorman, Temescal, and Striped Mountain) produced small amounts of tin before 1945. Only the Evening Star Mine on Striped Mountain is located in the CDCA. The area around this mine is still considered favorable for further discoveries. Tin also occurs in geothermal brines in the Salton Sea Known Geothermal Resource Area (KGRA), but has never been produced from this source.

Substitutes: Various metals and plastics can be substituted for tin in some applications.

Price: 1979 - $7.54 per pound, New York composite price.

References: 54, 55.

TIN IN THE CDCA

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production (lbs.)	Reserves[1] Resources[2] (lbs.)	Value ($ X 10^6)	Reference Number
98	Evening Star	Ivanpah Mtns.	Clark Mountain	48,000		0.362	41, 113
160	Salton Sea KGRA	Niland	Salton Sea		5,000,000[2]	37.700	111
	Total Production			48,000		0.362	
	Total Resources				5,000,000	37.700	

Tungsten (W)

Uses: Metal working and machinery construction 77%, transportation 10%, lamps and lighting 6%, electrical 4%, and other 3%.

Consumption: During 1979, the apparent U.S. consumption of tungsten was 23,701,000 pounds of tungsten metal, of which 11,352,000 pounds of tungsten concentrate were imported.

Trends: The demand for tungsten is increasing at an annual rate of 8%, based on 1978-79 figures. Demand is currently 5% higher than existing production.

Production: In 1979, about 97% of domestic production came from four mines located in California, Colorado, and Nevada. The U.S. produced 6,643,000 pounds of tungsten that year, including 1,929,000 pounds of exported tungsten concentrates. Net import reliance is 53% of consumption. The CDCA has been a major past producer of tungsten from placers, and now another source of tungsten, the brines of Searles Lake, are producing this metal. Smaller skarn deposits have been worked in the past. Tungsten reserves are found in the placers of Atolia and the brines of Searles Lake. Development of these reserves should be expected.

Substitutes: Titanium carbide, tantalum carbide, and columbium carbide substitute for tungsten in some wear-resisting uses. Molybdenum tool steels can substitute for tungsten tool steels. Bulk ceramics, nitrides, carbonitrides, and alumina coatings on some tungsten carbide inserts can reduce the amount of tungsten needed for these products.

Price: 1979 - $133.13 per short ton unit WO_3 (i.e. per 20 lbs.)

References: 54, 55, 86.

Map -XIV-2- No.	Deposit	Location	GRA	Production (stu)	Reserves[1] Resources[2] (stu)	Value ($ X 10^6)	Reference Number
51	Atolia	Atolia	Red Mountain	1,000,000		133.130	94, 113
	"	"	" "		280,000[1]	37.276	45
18	Darwin District	Darwin	Darwin-Slate Range	55,940		7.447	37
	" "	"	" " "		Large		37
143	Hidden Value	Old Woman Mtns.	Old Woman Mtns.	500		0.067	113
46	Hi Peak	Inyokern	Owens Peak	4,000		0.533	94
143	Howe	Old Woman Mtns.	Old Woman Mtns.	923		0.123	113
128	Just	Helendale	Adobe Mountain	1,750		0.233	113
90	Mohave	Clark Mountain	Clark Mountain	1,924		0.256	41, 113
171	PK	Jacumba	Yuha	660		0.080	62
44	Searles Lake	Searles Lake	Searles		8,500,000[1]	1,131.605	3
40	76 Mine	Slate Range	Darwin-Slate Range	43,290		5.763	21
61	Star Bright	Lane Mountain	Calico Mtns.	20,000		2.663	113
	Total Production			1,128,987		150.302	
	Total Reserves				8,780,000	1,168.881	

Zinc (Zn)

Uses: Construction materials 40%, transportation equipment 26%, electrical equipment 12%, machinery and chemicals 10%, and other 12%.

Consumption: In 1980 the apparent U.S. consumption of zinc was estimated to be 920,000 metric tons, of which 592,533 metric tons (64%) were imported.

Trends: From a 1976 base year, domestic demand for zinc is expected to increase at an annual rate of 2% through 1985.

Production: The U.S. produced 369,852 metric tons of zinc from primary (mining) and secondary (recycling) sources in 1980. Zinc exports totalled 54,759 metric tons that year.

About 97% of domestic production comes from 25 mines, with five of these mines producing 55% of U.S. output. Major producing states are Tennessee 31%, Missouri 23%, New Jersey 12%, Idaho 12%, and others 22%.

The CDCA has produced zinc from various lead-zinc-silver mines in the Darwin District, Ivanpah District, Cerro Gordo District, Shoshone District, and several smaller operations. The recent increase in silver activity is expected to continue in the CDCA, so the future for zinc production in the CDCA is excellent. Zinc carbonate ore in the Panamint Mountains and in the Darwin District are potential sources of future zinc production.

Substitutes: Aluminum and magnesium are the major substitutes for zinc in die casting. Plastics, paints, cadmium, and special steels can replace zinc in corrosion control. Aluminum, magnesium, titanium, and zirconium compete with zinc in chemicals and paints.

Price: 1979 - $0.3730 per pound (delivered).

References: 16, 54, 55.

ZINC IN THE CDCA

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production* (lbs.)	Reserves[1] Resources[2] (lbs.)	Value ($\$ \times 10^6$)	Reference Number
11	Big Four	Panamint Range	Talc City Hills	117,200		0.044	38
95	Carbonate King	Ivanpah Mtns.	Clark Mountain	5,534,213		2.064	41
14	Cerro Gordo District	Inyo Mtns.	Talc City Hills	24,213,640		9.032	53
18	Darwin District	Darwin	Darwin/Slate Range	52,124,947		19.443	37
39	Honolulu-Big Horn	South Park Canyon	Panamint Range	550,000		0.205	64
10	Lemoigne	Panamint Butte	DVNM: Tucki Mtn.	52,240		0.020	38
21	Modoc District	Argus Range	Darwin/Slate Range	217,000		0.081	38
92	Mohawk Mine	Mountain Pass	Clark Mountain	1,094,800		0.408	41
160	Salton Sea KGRA	Niland	Salton Sea		2,500,000[2]	0.933	111
79	Shoshone Mines	Shoshone	Resting Spring Rng.	16,000,000		5.968	35
20	Zinc Hill	Argus Range	Darwin/Slate Range	3,500,000		1.306	36
	Total Production			103,404,040		38.569	
	Total Resources				2,500,000[2]	0.933	

* Zinc producers of over 50,000 lbs., there are numerous smaller producers.

Gold (Au)

Uses:	Jewelry and arts 58%, electronics and other industries 28%, dental 13%, and small bars for investment 1%.
Consumption:	In 1979, U.S. domestic consumption was 5,100,000 troy ounces. Gold imports totalled 4,630,000 troy ounces, excluding coinage imports, and 5,510,000 troy ounces were exported.
Trends:	From a 1978 base, domestic gold demand is expected to increase at an annual rate of 3% through 1985.
Production:	The U.S. produced 920,000 troy ounces in 1979 and recycled an estimated 3,200,000 troy ounces. The U.S. had a net import reliance of 53% in 1978, measured against apparent domestic consumption. Gold was produced from 175 mines in the U.S. Three of these mines accounted for 65% of the total output. About 40% of gold produced is recovered as a byproduct of base metal (Cu-Pb-Zn) mining operations. California produced 3,195 troy ounces in 1979, mostly from the Mother Lode area. The reserves of gold in the CDCA are inferred to be large. The CDCA was a major producer of gold from high-grade vein systems, placers, and as a byproduct of base metal mining. It is now being actively explored by companies for large tonnage low-grade deposits. Several deposits have been located in the Panamint Mountains, Clark Mountain, and Randsburg areas. Former areas of production will be producing again due to improved prices and technology for handling low-grade ores. The recent decline in gold prices may affect the economic viability of some gold operations.
Substitutes:	Gold alloys plated over base metals are used to economize on the use of gold. Palladium, platinum, and silver may substitute for gold.
Price:	1979 - $217.15 to $517.00 (av. $307.50) per troy ounce. Gold prices fluctuate wildly.
References:	50, 54, 55.

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production* (troy oz.)	Reserves[1] Resources[2] (troy oz.)	Value ($ X 10^6)	Reference Number
65	Alvord	Alvord Mountains	Alvord	2,420		.744	113
33	Ashford	Death Valley	DVNM: Black Mtns.	6,174		1.899	98
151	Brown-Gray Mines	Arica Mountains	Big Maria Mountains	5,000		1.538	107
137	Bagdad Chase	Ludlow	Cady Mountains	261,840		80.516	113, 21
108a	Bighorn	Hidden Hill	Providence Mtns.	5,000		1.538	113
150	Bendigo District	Riverside Mountains	Riverside Mountains	3,116		.958	76
5	Beveridge	Inyo Mountains	Inyo Mountains	4,000		1.230	19
"	"	"	"		25,000[1]	7.688	32
127	Black Hole	Mirage Lake	Adobe Mountains		352,000[1]	108.240	25
14	Cerro Gordo Dist.	Inyo Mountains	Talc City Hills	3,291		1.012	53
94	Colosseum	Clark Mountain	Clark Mountains		1,400,000[2]	430.500	21
60	Coolgardie	Lane Mountain	Calico Mountains	4,838		1.488	19
132	Dale District	Twentynine Palms	Dale Lake	185,000		56.888	105
18	Darwin District	Darwin	Darwin-Slate/Rng.	5,914		1.819	36
130a	Desert Queen	Joshua Tree	JTNM-East	3,837		1.180	76
130	El Dorado	Joshua Tree	JTNM-East	2,000		.615	76
120	Gold Peak	Fry Mountains	Rodman Mountains	2,000		.615	113
100	Golden Quail	New York Mtns.	New York Mtns.		18,375[1]	5.650	64a
122	Grapevine Canyon	San Bernardino Mtns	Stoddard	3,000		.923	74
45	Hafford	Slate Range	China Lake-Mojave B		7,143[1]	2.197	99
24	Harrisburg	Death Valley	DVNM-Tucki Mtn.	15,000		4.613	19
161	Iron Chief	Eagle Mountains	Eagle Mountains	7,257		2.232	19
42	January Jones	Slate Range	Darwin/Slate Range	4,000		1.230	24
8	Keane Wonder	Death Valley	DVNM-Funeral Mtns.	53,217		16.364	19
124	Keystone	Stoddard Mtn.	Stoddard	6,000		1.845	113
6	Lost Burro	The Racetrack	DVNM-Cottonwood Mts.	5,000		1.538	19
130	Lost Horse	Joshua Tree	JTNM-West	16,932		5.207	19
21	Modoc District	Argus Rng.	Darwin/Slate Range	2,020		.621	38
55	Mojave District	Rosamond	Soledad/Rosamond	579,360		178.153	94,97,101
96	Morning Star	Ivanpah Mountains	Clark Mountains		100,000[1]	30.750	113
38	Panamint Range	Panamint Range	Panamint Range	102,304		31.458	108
"	"	"	"		467,500[2]	143.756	108
163	Paymaster	Chocolate Mountains	Palo Verde Mtns.	3,750		1.153	62, 35
111	Paymaster	Old Dad Mountain	Old Dad Mountain	5,000		1.538	113
164	Picacho	Picacho	Picacho	100,000		30.750	62, 19

GOLD IN THE CDCA (Continued)

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production* (troy oz.)	Reserves[1] Resources[2] (troy oz.)	Value ($ X 10^6)	Reference Number
165	Potholes	Laguna Dam	Picacho	100,000		30.750	62
49	Randsburg District	Randsburg	Randsburg	859,670		264.349	94,113, 96, 97
"	"	"	"		4,000[1]	1.230	34
158	Red Cloud	Chuckwalla Mts.	Chuckwalla Mts.	2,857		.879	100
47	St. John	Sageland	Jawbone Canyon	33,866		10.414	94
41	St. Argus Range	Trona	Searles	29,347		9.024	64
"	"	"	"		4,571[1]	1.406	64
79	Shoshone Mines	Shoshone	Resting Spr. Rng.	7,300		2.245	35
9	Skidoo District	Death Valley	DVNM:Tucki Mtn.	200,000		61.500	30
"	"	"	"		83,900[1]	25.799	31
87	Telegraph	Halloran Sprs.	Cima Dome	2,559		.787	41
"	"	"	"		36,720[1]	11.291	67
166	Tumco District	Cargo Muchacho Mts.	Picacho	167,500		51.506	62
98	Vanderbilt District	New York Mountains	New York Mountains	62,093		19.093	41
	Total Production			2,862,462		880.207	
	Total Reserves				631,709	194.251	
	Total Resources				1,867,500	574.256	

* Gold Producers of over 2,000 ounces; there are numerous smaller producers not listed.


WILLIS

Potash (K_2O)

Uses: Fertilizer 95% and other 5%.

Consumption: Apparent U.S. consumption was 6,918,000 short tons of potash in 1979. That year 5,165,000 short tons of potash were imported.

Trends: In the U.S., demand for potash decreased 7% during 1980; however, from a 1978 base demand, it is expected to increase at an average annual rate of 2.2% to 1990.

Production: The U.S. produced 2,253,000 metric tons of K_2O equivalent in 1979. This means that potash ore, processed in 1979, contained the equivalent of 2,253,000 metric tons of K_2O. New Mexico is the major U.S. producer of potash. In the CDCA, potash occurs in brines in Searles Lake and the Salton Sea KGRA, and in clays near Randsburg.

Substitutes: There are no substitutes for potash fertilizers.

Price: 1979 - $117 per metric ton, f.o.b. mine, yearly average, K_2O equivalent.

References: 54, 55, 81.

POTASH IN THE CDCA

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production (MT)	Reserves[1] Resources[2] (MT)	Value ($ X 10^6)	Reference Number
160	Salton Sea KGRA	Niland	Salton Sea	Not avail.	77,129,000[2]	9,024.10	111
44	Searles Lake	Trona	Searles		57,166,200[1]	6,688.40	21
52	Randsburg	Red Mountain	Red Mountain		2,449,980[2]	286.65	15
	Total Reserves				57,166,200	6,688.45	
	Total Resources				79,578,980	9,310.74	

Strontium (Sr)

<u>Uses</u>: Manufacture of color TV tubes 65%, pyrotechnics and signals 15%, ferrite ceramic permanent magnets 5%, other 15%.

<u>Consumption</u>: In 1980, the U.S. consumed 19,900 short tons of strontium, all of which were imported. Almost all of the imported strontium minerals came from Mexico. West Germany was the major source of imported strontium compounds.

<u>Trends</u>: Consumption is expected to increase at an annual rate of 3% through 1985, using a 1977 base year.

<u>Production</u>: The U.S. produces no strontium domestically. Two U.S. companies, in California and Georgia, process strontium compounds. Celesite and strontianite occur in Cenozoic sedimentary rocks and in the carbonatite at Mountain Pass. Strontium also occurs in brines in the Salton Sea KGRA. Small amounts of strontium were produced from four deposits in the CDCA during World War I. Seven areas in the CDCA contain strontium reserves or resources.

<u>Substitutes</u>: There are no satisfactory substitutes for strontium.

<u>Price</u>: 1979 - $53.12 per ton, average value of imported strontium minerals, at port of exportation.

<u>References</u>: 54, 55, 88.

STRONTIUM IN THE CDCA

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production (Short Tons)	Reserves[1] Resources[2] (Short Tons)	Value ($ X 10^6)	Reference Number
69	Avawatz	N. Avawatz Mountains	Avawatz Mountains	None	300,000[2]	15.936	24
138	Bristol Dry Lake	Amboy	Bristol Lake	Minor			24
"	"	"	"		10,000,000[2]	531.200	24
113	Ludlow	Ludlow	Cady Mountains	Minor			24
"	"	"	"		200,000[1]	10.624	104
"	"	"	"		10,000,000[2]	531.200	104
93	Mountain Pass	Mountain Pass	Clark Mountain		4,400,000[1]	233.728	102, 110
168	Ocotillo	Fish Creek Mtns.	Yuha Basin	8,040		0.427	24
"	"	"	"		10,000[2]	0.531	24
160	Salton Sea KGRA	Niland	Salton Sea		1,250,000[2]	66.400	111, 20a
62	Solomon and Ross	Mud Hills	Calico Mountains	500		0.027	24
"	"	"	"		540,000[2]	28.685	24
	Total Production			8,540		0.454	
	Total Reserves				4,600,000	244.352	
	Total Resources				22,100,000	1,173.952	

*Figures indicate tonnage of rock containing strontium minerals of varying concentration.

Group III - Major Export Commodities on the World Market

Borates (B_2O_3)

Uses: Over 50% is used in glass manufacture, chemical fire retardants 15%, soap and detergents 10%, vitreous enamel 5%, agriculture-biological uses 5%, nuclear and metallurgical applications 2%.

Consumption: In 1979 the U.S. consumed 127,000 short tons of borates.

Trends: From a 1977 base, the demand for U.S. borates will be increased by 4% annually through 1985.

Production: Most of the borates in the free world are mined at three sites in the CDCA: Boron, Searles Lake, and the southern Death Valley-Ryan area. The total borate production in the U.S. in 1979, all from the CDCA, was 1,590,000 short tons. The U.S. exported 374,000 short tons of borates and boric acid.

The CDCA contains large borate resources and reserves, and mining of this commodity will continue.

Substitutes: Borates are essential components of thermal-shock-resistant glasses. Some substitutes are possible in soaps, detergents, paints, insulation, and agriculture.

Price: 1979 - $339.50 per short ton, technical grade, granular boric acid, 99.9% pure, bulk carlots, works.

References: 1, 54, 55.

BORATES IN THE CDCA

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production (short tons)	Reserves[1] Resources[2] (short tons)	Value ($ X 10^6)	Reference Number
64a	Borate	Calico	Calico	84,888		28.82	21
56	Boron	Boron	Boron	17,870,000		6,066.87	21
"	"	"	"		25,000,000[1]	8,487.50	21
"	"	"	"		700,000[2]	237.65	30
24a	Death Valley Playa	Death Valley	DVNM Tucki Valley	8,603		2.92	21
31	Furnace Creek Wash	Death Valley	DVNM: Black Mtn.	139,940		47.51	48, 30
"	"	"	"		2,041,200[1]	692.99	30
"	"	"	"		14,759,000[2]	5,010.68	30
76	Gerstley	Shoshone	Resting Spr. Rng.	38,820		13.18	21
"	"	"	"		89,628[1]	30.43	30
"	"	"	"		485,000[2]	164.66	30
115	Hector	Hector	Cady Mtns.		Poten. Res.		66
29	Lila C.	Death Valley Jct.	Greenwater Rng.	38,070		12.93	21
29a	Maria, Terry	Death Valley Jct.	Greenwater Rng.	4,050		1.38	6
"	"	"	"		1,000[1]	0.34	30
"	"	"	"		350,000[2]	118.83	30
57	Rho	Kramer	Boron		8,140,000[2]	2,763.53	29
30	Ryan	Ryan	Greenwater Rng.	569,490		193.34	21
"	"	"	"		1,157,213[1]	392.87	30
160	Salton Sea KGRA	Niland	Salton Sea		2,000,000[2]	679.00	111
44	Searles Lake	Trona	Searles	4,000,000		1,358.00	19
"	"	"	"		25,000,000[1]	8,487.50	1
	Total Production*			22,753,861		7,724.94	
	Total Reserves*				53,289,041	18,091.63	
	Total Resources*				26,434,000	8,974.34	

* Amount of contained B_2O_3.

Kyanite (Al_2SiO_5)

Uses: Major uses: refractories 96%, including smelting, glass-making, and furnace linings.

Consumption: The latest available figure indicates that the U.S. consumed an estimated 95,000 short tons of kyanite in 1976. Consumption since that time has probably increased.

Trends: The demand for kyanite and synthetic mullite is expected to increase by 6% per year through 1985. Export demand is also expected to be higher.

Production: All kyanite in the U.S. is mined in Virginia and Georgia. Past production in the CDCA came from the Cargo Muchacho Mountains in Imperial County between 1925 and 1956. A total of 31,000 short tons were produced in that time. An estimated 3,730,000 short tons of kyanite are contained in the Cargo Muchacho Mountains. Current U.S. production figures are not available. The U.S. is a net exporter of kyanite.

Substitutes: Synthetic mullite, a man-made high temperature aluminum oxide, can substitute for kyanite. Synthetic mullite is made from bauxite, kaolin, and other clays and silica sand.

Price: 1979 - $63-$117 per short ton, f.o.b. bulk, Georgia kyanite.

References: 54, 55, 69, 71.

KYANITE IN THE CDCA

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production (short tons)	Reserves[1] Resources[2] (short tons)	Value ($ X 10^6)	Reference Number
167	Bluebird	Cargo Muchacho Mtns.	Picacho	31,000		1.953	62
"	"	"	"		3,730,000[2]	234.990	
	Total Production			31,000		1.953	
	Total Resources				3,730,000	234.990	

Lithium (Li)

Uses: About 33% of domestic production was consumed in aluminum potlines (smelting of aluminum ores) and 40% in the manufacture of glass, ceramics, and specialty greases.

Consumption: Apparent U.S. consumption of contained lithium was estimated to be 3,200 short tons in 1979. The U.S. exported 2,400 short tons of contained lithium in chemicals that year.

Trends: Using 1978 as a base year, overall demand for lithium chemicals is expected to increase at an annual rate of 10% to 1985.

Production: Lithium is produced from spodumene-bearing pegmatite veins at two mines in North Carolina and from brines at Clayton Valley, Nevada. Approximately 5,244 short tons of contained lithium were produced by these operations in 1979. Lithium was produced from brines at Searles Lake, California, between 1936 and 1978. Production was phased out in 1978 due to economic considerations.

Lithium-bearing clays occur at Hector, Tecopa, Eureka Valley, Alkali Flat, and in association with borate deposits at Boron, Death Valley (Boraxo), and the Greenwater Range (Amargosa). These clays are potential lithium resources. Vine (1976) considered the material at Boron to be a low-grade, subeconomic lithium resource and calculated the amount of contained lithium. A later publication by Vine (1980) mentions the other lithium-clay occurrences listed above, but resource calculations to deduce the amount of contained lithium probably would not yield meaningful figures.

Substitutes: Other materials can be used in place of lithium in glasses, ceramics, greases, and batteries. These replacements include sodium and potassium in glasses and ceramics, calcium and aluminum in soaps and greases, and zinc, magnesium, calcium, and mercury as anode material in primary batteries.

Price: 1979 - $15.65 per 1,000 pound lot, lithium metal ingots.

References: 54, 55, 78, 105, 106.

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production (short tons)	Reserves[1] Resources[2] (short tons)	Value ($ X 10^6)	Reference Number
28	Alkali Flat	Death Valley Jct.	Pyramid Peak		Potent. Res.		106
30, 29	Amargosa Borates	Greenwater Range	Greenwater Range/ Pyramid Peak		Potent. Res.		106
31	Boraxo Pit	Furnace Creek Wash	DVNM Black Mtns.		Potent. Res.		106
56	Boron	Boron	Boron		66,152[2]	2.071	105
139	Bristol Lake*	Amboy	Bristol Lake		54,890[2]	1.718	106, 15
145	Cadiz Lake*	Cadiz Lake	Cadiz/Danby		7,440[2]	0.233	106, 15
146	Danby Lake*	Milligan	Cadiz/Danby		173[2]	0.005	106, 15
2	Eureka Valley	Eureka Valley	Eureka Valley		Potent. Res.		106
115	Hector	Hector	Cady		Potent. Res.		65
78	Lake Tecopa	Tecopa	Resting Spring		Potent. Res.		187
160	Salton Sea KGRA	Imperial Valley	Salton Sea		1,100,000[2]	34.430	111
44	Searles Lake	Trona	Searles	22,600		0.707	21
"	"	"	"		10,000[1]	0.313	65
"	"	"	"		30,000[2]	0.939	65
	Total Production			22,600		0.707	
	Total Reserves				10,000	0.313	
	Total Resources				1,258,655	39.396	

*Lithium resources were calculated from concentration in brine (Vine, 1980), and amount of brine (Calzia, and others, 1979).

Rare Earth Oxides (REOs), $(CeF)CO_3$

Uses: Petroleum catalysts 38%, steelmaking 38%, ceramic and glass 19%, other 5% (electrical, nuclear, super alloys, magnets, and color TV tubes).

Consumption: The apparent domestic consumption of REOs in 1978 was estimated at 20,000 short tons. The U.S. imported 7,654 short tons of REOs.

Trends: From a 1977 base year, domestic consumption is expected to increase at an annual rate of 6% through 1985. Foreign imports increased due, in part, to the closing of a Florida monazite operation in 1979.

Production: The world's major producer of REOs from basnaesite is Molycorp, Inc., at Mountain Pass, California. The U.S. imports monazite from several countries; however, these ores do not contain the entire suite of rare earth elements, so the deficiency must be extracted from the basnaesite ores of Mountain Pass. The 1978 production of basnaesite from Mountain Pass was 15,595 short tons. The amount of REOs exported each year from Mountain Pass is unknown since the data is proprietary and withheld by the Bureau of Mines.

The present U.S. reserves of basnaesite are located in the vicinity of Mountain Pass, California. The 1980 Annual Report of Union Oil Company of California states that this deposit contains an estimated 44,000,000 short tons of proven and probable ore, averaging 7.68% REO.

Substitutes: In major use categories, there are no suitable substitutes now known. In minor use areas, substitutes are available, but are less effective than the rare earth elements.

Price: 1979 - $0.80 per pound rare earth oxide, basnaesite concentrate.

References: 40, 54, 55, 102.

RARE EARTHS IN THE CDCA

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production (short tons)	Reserves[1] Resources[2] (short tons)	Value ($ X 10^6)	Reference Number
93	Mountain Pass	Mountain Pass	Clark Mtn.	250,000		400.00	21
"	"	"	"		3,379,200[1]	5,406.72	102
131	Music Valley	Twentynine Palms	Dale Lake		Potent. Res.		28
	Total Production			250,000		400.00	
	Total Reserves				3,379,200	5,406.72	

Sodium Carbonate (Na_2CO_3)

Uses: About 55% of domestically consumed soda ash was used in glass manufacturing. Chemical reagents consumed 23%, detergents 5%, pulp to paper 3%, water treatment 3%, others 11%. About 9% was exported.

Consumption: The U.S. consumed 7,304,000 short tons of Na_2CO_3 in 1979. Exports reached 997,000 short tons in 1979, while the U.S. imported 40,000 short tons that year.

Trends: The demand for soda ash, based on 1977 projections, is expected to increase by 1.8% per year through 1985, though there was a slight decrease in demand in 1978 and 1979.

Production: The U.S. is the world's largest producer of sodium carbonate. The national production of soda ash in 1979 was 8,253,000 short tons. The CDCA produced 17% of that, or 1,400,000 tons, from the Kerr-McGee plant in Trona, California. A large amount of sodium carbonate has been produced from the brines at Searles Lake, but the production figures are not available. The reserves at Searles Lake are large and are estimated to have a production life of 770 years at the present annual rate of 1,400,000 short tons.

Substitutes: Caustic soda can be substituted for soda ash but at a higher cost.

Price: 1979 - $64.55 per short ton, bulk soda ash.

References: 21, 44, 54, 55.

SODIUM CARBONATE IN THE CDCA

Map -XIV-2-1 No.	Deposit	Location	GRA	Production (short tons)	Reserves[1] Resources[2] (short tons)	Value ($ X 10^6)	Reference Number
44	Searles Lake	Trona	Searles	Not Avail.	700,000,000[2]	45,185.00	44

Uranium (U), (U_3O_8)

Uses: The major uses of uranium are as a nuclear fuel in generating electrical power and in weapons manufacture for the military. Small amounts are used in pure research. Depleted uranium is used for armor-piercing shells, containers for radioactive waste, radiation shielding, aircraft counterweights, ballast, and research.

Consumption: The United States' apparent non-energy consumption of depleted uranium was estimated at 4,250 short tons in 1979, while the U_3O_8 requirements were forecast to be 12,800 short tons that year. There are contracts for 3,600 short tons of U_3O_8 imports into the U.S. in 1981.

Trends: It is expected that domestic demand for depleted uranium will increase at an annual rate of 5% through 1985, using 1978 as a base year.

Production: The U.S. produced approximately 20,200 short tons of U_3O_8 and 18,860 short tons of depleted uranium in 1978. Most of the U.S. production comes from New Mexico, Arizona, Wyoming, Colorado, Nevada, Texas, and Florida.

Uranium deposits in the CDCA produced small amounts of ore in the 1950s. Precambrian sedimentary rocks and Tertiary and late Cretaceous volcanic sediment rocks are the most important sources of uranium discovered thus far in the California Desert. Mesozoic granitic rocks host smaller uranium occurrences. Exploration for uranium is occurring and is expected to continue, though there are no producing uranium mines at this time.

Substitutes: For reactors and weapons, thorium or plutonium may be substituted. However, plutonium is produced from uranium. Depleted uranium can be replaced by lead, tungsten, or other dense metals.

Price: 1979 - $42.56 per pound U_3O_8, NUEXCO Exchange Value (Nuclear Exchange Corporation's judgement of the price at which transactions for significant quantities of natural uranium concentrates could be concluded. Monthly figures were averaged to produce the $42.56 figure. There is no standard price for uranium.)

References: 54, 55, 87, 112.

Map -XIV-2-1 No.	Deposit	Location	GRA	Production (short tons)	Reserves[1] Resources[2] (short tons)	Value ($ X 10^6)	Reference Number
156	Big Maria Mtns.	Big Maria Mtns.	Big Maria Mtns.		2,000[2]	170.240	72
53	Castle Butte	California City	Red Mountain		91[2]	7.746	12
17	Coso	Haiwee Res.	Haiwee Res.	.3		.026	43
"	"	"	"		273[1]	23.238	7
59	Barstow Formation	Gravel Hills - Mud Hills	Calico		91[2]	7.746	12
157	McCoy Mtns.	McCoy Mtns.	Palen/McCoy Mtns.	.85		.072	26
"	"	"	"		91[2]+	7.746	7
55	Northwestern Mojave	Soledad Mtn.	Soledad/Rosamond		10,000[2]	851.200	72
37	Panamint Range	Happy Canyon	Panamint		91[2]	7.746	7
78	Tecopa	Tecopa	Resting Spr. Range		91[2]	7.746	12
163	Crown Mine	Chocolate Mtns.	Picacho	15		1.277	21
	*Total Production			16.15		1.375	
	*Total Reserves				273	23.238	
	*Total Resources				12,455	1,060.169	

* Amount of contained U_3O_8.

Group IV - Commodities of Local or Regional Economic Significance

Barite ($BaSO_4$)

Uses: Oil/gas drilling muds 94%; other (paints, chemicals, glass, rubber) 6%.

Consumption: The apparent U.S. consumption of barite in 1980 was 3,774,000 short tons, according to preliminary figures from the U.S. Bureau of Mines. Barite imports totalled 1,850,000 short tons.

Trends: From a 1978 base, the demand for barite is expected to increase by an average of 4% annually through 1985.

Production: The U.S. production of barite was approximately 2,768,000 short tons in 1980. Exports totalled 97,000 short tons. In California, barite was produced from one mine in Nevada County in 1980.

A small amount of barite was produced in the CDCA in the 1930s. There are no present producers of barite. In the CDCA, barite occurs with the rare earth ore at Mountain Pass. Although it can be extracted from this ore, barite is not presently marketed. The brines in the Salton Sea KGRA are a possible source of barium.

Substitutes: Celestite, iron ores, and synthetic hematite can replace barite in drilling mud. Some of these are more expensive than barite, so the substitutes do not cause major effects on the barite market.

Price: 1979 - $24.80 per short ton, average value, f.o.b. mine site.

References: 54, 55, 60.

BARITE IN THE CDCA

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production (short tons)	Reserves[1] Resources[2] (short tons)	Value ($ X 10^6)	Reference Number
69	Avawatz Mts.	N. Avawatz Mts.	Avawatz Mts.		Potent. Res.		10
64	Barstow Area	Calico Mtns.	Calico Mtns.	1,000		.025	113
"	"	"	"		450,000[1]	11.16	2, 90
32	Greenwater Range	Greenwater Range	Greenwater Range		Potent. Res.		23
93	Mountain Pass	Mountain Pass	Clark Mtn.		11,000,000[2]	272.80	11
160	Salton Sea KGRA	Niland	Salton Sea		1,250,000[2]	31.00	110
147	Silver King	Savahia Peak	Whipple Mtns.		Potent. Res.		21
84	Siluran Hills	Silver Lake	Halloran		Potent. Res.		47
	Total Production			1,000		.025	
	Total Reserves				450,000	11.16	
	Total Resources				12,250,000	303.80	

Clays

<u>Uses</u>: Clays are utilized in many ways; for example, the manufacture of ceramics, drilling mud, iron production, cosmetics, fillers in wood and plastic products, fertilizers, and steel casting.

<u>Consumption</u>: In 1979, the apparent U.S. consumption of clays was 51,595,000 short tons. This country imported 51,000 short tons and exported 3,205,000 short tons of clay in 1979.

<u>Trends</u>: An annual increase of 6% in consumption is forecast through 1985, using a 1977 base year.

<u>Production</u>: Clays are produced in most states in this country. Total domestic production of all clays in 1979 was 54,949,080 short tons. At least five areas in the CDCA are producing clay, although production figures are unavailable.

Bentonite, montmorillonite, and hectorite are all produced in the CDCA. Hectorite is a type of montmorillonite. Bentonite is a rock composed of various clays, including those of the montmorillonite group.

<u>Substitutes</u>: In limited uses, talc, whiting, and other commodities can be substituted for clays used as fillers or extenders. There are no substitutes for ceramic, casting, or drilling mud clays.

<u>Price</u>: 1979 - $24.04 per short ton, average value, bentonite.

<u>References</u>: 4, 54, 55.

Map -XIV-2-1 No.	Deposit	Location	GRA	Production (short tons)	Reserves[1] Resources[2] (short tons)	Value ($ X 10^6)	Reference Number
16	Calearth (M)	Olancha	Haiwee Reservoir	Not Avail.			
"	"	"	"		45,000[1]	1.082	64
"	"	"	"		180,000[2]	4.327	64
63	Dead Mtns. (B)	Dead Mountains	Homer Mountain	Minor	413,000,000[2]	9,928.520	66
48	El Paso Mtns. (B)	El Paso Mountains	El Paso Mountains	Not Avail.	1,700,000[2]	40,868.000	94
99	Hart (M)	Castle Mountains	Homer Mountain	Not Avail.	250,000[1]	6.010	113
115	NL Inc. (H)	Hector	Cady Mountain	Not Avail.	500,000[2]	12.020	113
75	Shoshone (B, S)	Shoshone	Resting Spring Rng.	Not Avail.	33,000,000[1]	793.320	64
"	"	"	"		5,600,000[2]	134.624	64
73	Tecopa (B, S,)	Tecopa	Resting Spring Rng.	Not Avail.	2,500,000[2]	60.100	21
26	White King (H)	Ash Meadows	Pyramid Peak	Minor	3,560,000[1]	85.582	21
	Total Reserves				36,855,000	885.994	
	Total Resources				423,480,000	10,180.459	

H=Hectorite
B=Bentonite
M=Montmorillonite
S=Sepiolite

Geothermal

Uses: Geothermal products (hot water and steam) have two major uses. One is electric power generation and the other is direct heat application such as space heating, hydrophonics, and industrial requirements for process heating.

Consumption: The U.S. is or will be generating electrical power from geothermal reservoirs in Utah, New Mexico, and California. Power generation is currently occurring only in California (in the Geysers (northern California), and in the CDCA).

Trends: The recent technological breakthroughs in noncorroding alloys and in plant design will allow geothermal power plants to be rapidly placed on line once a reservoir is proven.

Production: Electrical power is currently being generated at the Geysers area in northern California and in Imperial County in southern California. In the CDCA, electrical power is being generated from geothermal resources at Brawley and East Mesa, and a power plant at Heber is expected to come into production soon. Brawley and East Mesa each produce 10 megawatts of electricity per hour. California currently generates 900 MW of electric power from geothermal sources. By 1985 this figure will rise to at least 1500 MW.

There are 22 geothermal areas in the CDCA, of which 7 are capable of either electrical generation or direct heat utilization.

Substitutes: Coal, oil, gas, or nuclear fuels may be substituted for geothermal power, but they usually require more environmental control than geothermal energy.

Price: 1979 - Approximately $5,000 per Megawatt of output in tax revenues to the county of origin.

References: 15, 39a, 41a.

DEPOSIT	Location	GRA	Temp. (C°)	Potential Megawatts	Ref. #
Amboy Area	Amboy Crater	Bristol Lake	?	Moderate	41a
Brawley KGRA	Brawley	Imperial Valley	200	640	41a
Coso KGRA	Coso Hot Springs	Haiwee Res./ China Lake	174	650	41a
Desert Center	Desert Center	Eagle Mountains	30[3]	Unknown	41a
Desert Hot Springs	Desert Hot Springs	Morongo Valley	70[3]	Dir. Heat	41a
Dunes KGRA	East Mesa	East Mesa South	132[2]	Good	41a
East Brawley	Brawley	Imperial Valley	132[2]	Good	41a
East Mesa KGRA	East Mesa	East Mesa South	190	360	41a
Ford Dry Lake KGRA	Ford Dry Lake	Palen/McCoy Mtns.	48[3]	Good	41a
Glamis KGRA	Glamis	East Mesa North	132[2]	Good	41a
Heber KGRA	Herber	Imperial Valley	180	650	41a
Mecca	Mecca	Coachella	31[3]	Dir. Heat	41a
Ocotillo Wells	Ocotillo Wells	Borrego Springs	38[3]	Dir. Heat	41a
Pisgah Crater	Pisgah Crater	Cady Mtns.	?	Unknown	41a
Randsburg KGRA	Randsburg	Red Mtn.	116	84	41a
Saline Valley KGRA	Saline Valley	Saline Valley	49	Dir. Heat	41a
Salton Sea KGRA	Niland	Salton Sea	340[1]	3,400	41a
Searles Lake	Searles Lake	Searles	58[3]	Moderate	41a
Tecopa Hot Springs	Tecopa	Resting Spg. Rng.	48	Dir. Heat	41a
Truckhaven	Salton City	Salton Sea	59[3]	Good	41a
Twentynine Palms	Twentynine Palms	Dale Lake	60[3]	Dir. Heat	41a
Westmoreland KGRA	Westmoreland	Imperial Valley	217	1,710	41a
Yuha Basin	Yuha Basin	Yuha Basin	30[3]	Good	41a

[1]MWe = Megawatts of electric power [2]Estimated from temperature gradient surveys
[3]Temperature of water from wells.

Gypsum ($CaSO_4 2H_2O$)

<u>Uses</u>:	Plaster of paris, cement, agricultural soil conditioning, gypsum board for building construction.
<u>Consumption</u>:	In 1979, the apparent U.S. consumption was 22,300,000 short tons of gypsum. The U.S. imported 13,186,000 short tons and exported 11,588,000 short tons of gypsum that year.
<u>Trends</u>:	From a base year of 1977, the annual demand is expected to increase by 2.7 percent through 1985.
<u>Production</u>:	In 1979 the U.S. produced 14,630,000 short tons of crude gypsum. The leading producing states are Michigan, Texas, Iowa, California, Oklahoma, and Nevada. In 1979, California produced 1,624,000 short tons, 11% of the U.S. production. Most of the California production came from Imperial and Riverside counties, within the CDCA. A new mine in the Little Maria Mountains is currently under development. The CDCA is expected to continue to be an important source of gypsum in the U.S.
<u>Substitutes</u>:	Other construction materials may replace gypsum, except in cement.
<u>Price</u>:	1979 - $6.83 per short ton, average value.
<u>References</u>:	54, 55.

GYPSUM IN THE CDCA

Map -XIV-2-1 No.	Deposit	Location	GRA	Production (short tons)	Reserves[1] Resources[2] (short tons)	Value ($ X 10^6)	Reference Number
67	Avawatz Mountains	Avawatz Mountains	Avawatz Mountains	None	535,160,305[2]	3,655.15	103
155	Big Maria Mountains	Big Maria Mountains	Big Maria Mountains	Minor	67,981,355[2]	463.33	103
170a	Coyote Mts.	Coyote Mts.	Yuha Basin	Minor	90,000,000[2]	614.70	62
169	Fish Creek Mtns.	Fish Creek Mtns.	Yuha Basin	17,000,000		116.11	21
"	"	"	"		271,546,753[2]	1,854.66	62
154	Midland	Little Maria Mtns.	Big Maria Mountains	1,487,864		10.16	76
"	"	"	"		1,409,449,762[2]	9,626.54	103
152	Palen Pass	Palen Mountains	Palen/McCoy	Minor	284,384,537[2]	1,942.35	42
150	Riverside Mountains	Riverside Mountains	Riverside Mountains	Unknown	102,513,590[2]	700.17	103
88	Shire	Clark Mountains	Clark Mountains	Unknown	99,237,529[2]	677.79	113
	Total Production			18,487,864		126.27	
	Total Resources				2,860,273,831	19,535.67	

Iron (Fe)

Uses: The major uses of iron are in the production of various types and alloys of iron, steel, and cement.

Consumption: The United States consumed 125,431,000 long tons of iron in 1979. Exports amounted to 5,148,000 long tons, and 33,776 long tons were imported that year.

Trends: The annual demand for iron ore in the United States is expected to increase at a rate of 2% through 1985, using 1976 as a base year.

Production: The U.S. produced 85,716,000 long tons in 1978. There are several producing iron mines in the CDCA of which Kaiser Steel's operation at Eagle Mountain is the largest. Iron ore from Eagle Mountain is refined at Kaiser's Fontana Steel Mill. Other smaller mines produce iron ore for the cement industry in southern California. Small amounts are shipped to Japan.

Substitutes: There are no substitutes for the major uses of iron.

Price: 1979 - $32.64 per long ton, f.o.b. mine site.

References: 54, 55, 58.

IRON IN THE CDCA

X 1.15 = Short tons

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production (Long Tons)	Reserves[1] Resources[2] (Long Tons)	Value ($ X 10^6)	Reference Number
67	Bat	Silver Lake	Avawatz Mountains	30,000		.979	21
"	"	"	"		1,100,000[1]	35.904	21
117	Bessemer	Galway Lake	Rodman Mountains	28,000		.914	33
"	"	"	"		1,800,000[1]	58.752	33
66	Cave Canyon	Cave Canyon	Cady Mountains		6,700,000[1]	218.688	21
159	Desert Eagle	Eagle Mountain	Eagle Mountain		100,000,000[2]	3,264.000	21
160	Eagle Mountain	Eagle Mountain	Eagle Mountain	215,892,921		7,046.745	21
"	"	"	"		400,000,000[1]	13,056.000	21
133	Iron Age	Dale	Dale Lake	1,000,000		32.640	58
140	Iron Hat	Marble Mountains	Marble Mountains		185,000[1]	6.038	33
67	Iron King	Silver Lake	Avawatz Mountains		375,000[1]	12.240	33
67	Iron Mountain	Silver Lake	Avawatz Mountains	700,000		22.848	77
"	"	"	"		6,175,000[1]	201.552	33
109	Kelso Dunes	Kelso Dunes	Granite Mountains		100,000,000[2]	3,264.000	21
82	Kingston Mountains	Kingston Mountains	Kingston Mountains	2,087,979		68.152	21
"	"	"	"		6,000,000[1]	195.840	21
118	Man-Ord	Rodman Mountains	Rodman Mountains		100,000,000[2]	3,264.000	21
116	Morris Lode	Galway Lake	Rodman Mountains	17,500	1,750,000[1]	5.710	33
160	Salton Sea KGRA	Niland	Salton Sea		8,928,571[2]	291.429	111
142	Ship Mountain	Ship Mountain	Marble Mountains	1,500		.049	33
"	"	"	"		80,000[1]	2.611	33
108	Vulcan	Providence Mtns.	Providence Mtns.	2,643,000		86.268	33
"	"	"	"		5,680,000[1]	185.395	33
39	Whittaker	Argus Range	Darwin/Slate Range	10,000+		.326	64
	*Total Production			222,410,900		7,259.492	
	*Total Reserves				429,845,000	14,030.141	
	*Total Resources				300,898,571	9,821.329	

*Figures indicate tonnage of rock containing iron ore of varying concentration.

Limestone, Lime and Cement ($CaCO_3$ & $CaMgCo_3$)

Uses: The major uses of limestones are in the manufacture of various cements and lime products and as a petroleum product substitute in feedstocks for plastics and paints. Other uses are production of carbon dioxide, metallurgical fluxes, and as sulphur dioxide scrubber on fossil fueled power plants.

Consumption: The apparent United States consumption of lime in 1979 was 21,034,000 short tons. Lime imports totalled 685,000 short tons in 1979, and 41,000 short tons were exported. The apparent U.S. consumption of cement was 87,799,000 short tons in 1979. Cement imports totalled 9,393,000 short tons in 1979, and 149,000 short tons were exported. Southern California is a net exporter of portland cement, but is a net importer of limestone for petroleum product substitutes.

Trends: Cement consumption is expected to increase at 3% annually nationwide and at 5% in southern California. Lime demand is expected to increase 3.9% annually through 1985, from a 1977 base year. The demand for limestone substitutes for petroleum as plastic filler is expected to increase in excess of 5% annually.

Production: U.S. producers used or sold 20,983,000 short tons of lime in 1979. California producers used or sold 563,000 short tons of lime that year, and 898,000 short tons were imported into the State, making California a net importer of lime. The U.S. produced 82,071,000 short tons of portland and masonry cements in 1979. That year, southern California produced 6,921,000 short tons of portland cement and imported 5,734,000 short tons, for a net export of 1,187,000 short tons. No masonry cement was produced in southern California. There are several cement producers in the CDCA that mine limestone deposits. The number of limestone mines in the CDCA will begin to increase in 1985, and by 2000, all of the current cement producers in southern California will be obtaining their limestone in the CDCA due to depletion of their deposits outside the CDCA.

There are several limestone quarries on the north slope of the San Bernardino Mountains, outside of the CDCA. Kaiser, Pluess-Stauffer, and Pfizer have the largest of these operations. Each company operates large plants inside the CDCA in the southern Lucerne Valley.

In southern California, current production of limestone for cement is 12,000,000 short tons, and an additional 1,000,000 to 2,000,000 short tons are mined for lime and limestone products on an annual basis.

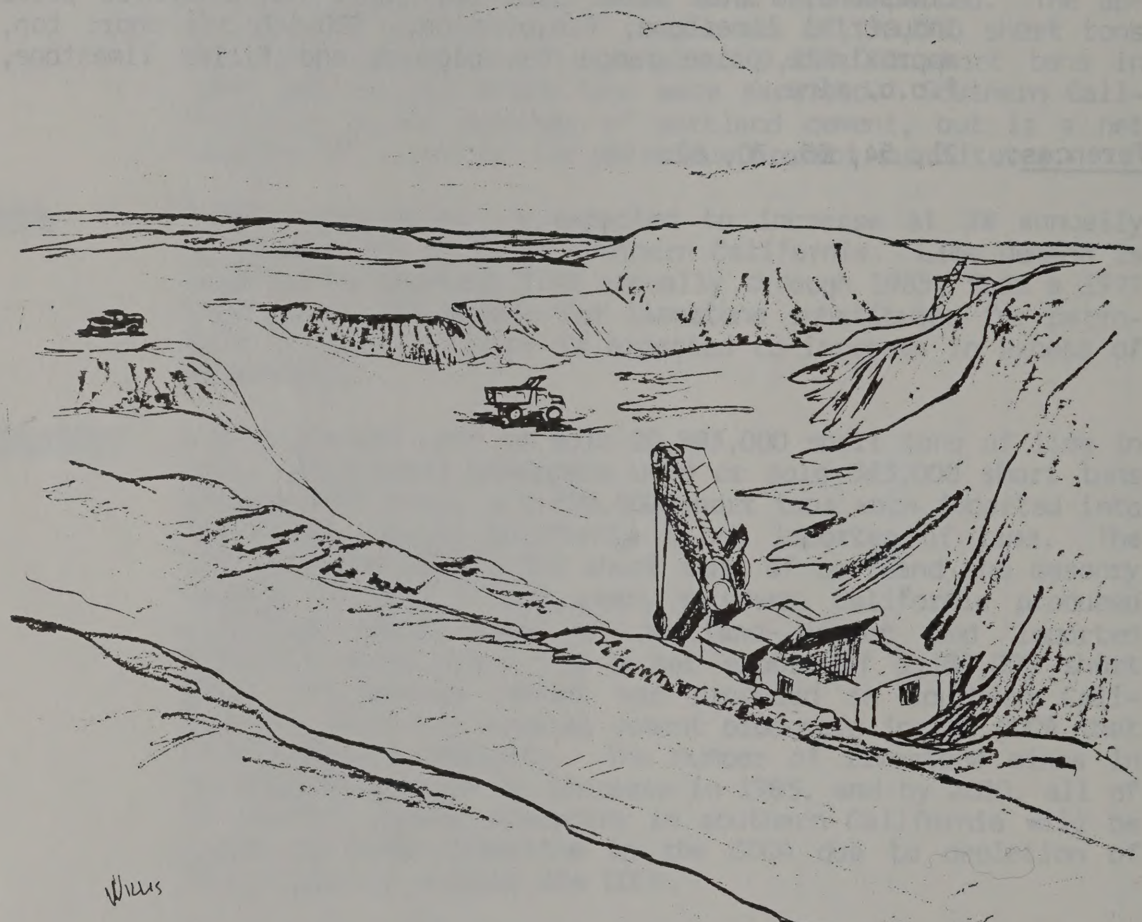
Most limestone produced in the CDCA is quarried by cement manufacturers for use in cement. This limestone is only sold as the final product - cement. It is not sold as

limestone. Higher quality, metallurgical grade filler and pigment limestone from the CDCA is sold on the open market. The value of limestone in the CDCA was calculated by using the minimum estimated value of limestone obtained from a cement industry source.

Substitutes: Limestone products can be supplanted by the following: Lime products: calcined gypsum. Cement: metals, wood, fiberglass, stone, and clay products.

Price: 1979 - $4 per short ton, estimated price, cement grade limestone, f.o.b. mine. $16 per short ton estimated price industrial limestone, f.o.b. mine. $20-$80 per short ton, approximate price range for pigment and filler limestone, f.o.b. mine.

References: 21, 54, 55, 70, 82.


Willis

LIMESTONE IN THE CDCA

Map -XIV-2-1 No.	Deposit	Location	GRA	Production (short tons)	Reserves[1] Resources[2] (short tons)	Value ($ X 10^6)	Reference Number
65	Alvord Mountains	Alvord Mountains	Alvord Mountains	None	25,000,000[2]	100.0	21
66	Baxter	Cave Mountain	Cudy Mountains	500,000		2.0	66
"	"	"	"		30,000,000[2]	120.0	21
155	Big & Little Maria Mountains	Big & Little Maria Mountains	Big Maria Mountains	None	100,000,000[1]	400.0	21
					300,000,000[2]	1,200.0	21
123	Black Mountains	Victorville	Stoddard	40,000,000		160.0	21
"	"	"	"		55,000,000[2]	220.0	21
144	Chubbuck	Chubbuck	Cadiz/Danby Lake	500,000		2.0	112
"	"	"	"		100,000,000[2]	400.0	112
170	Coyote Mountain	Coyote Mountain	Yuha Basin	Minor	202,000,000[2]	808.0	21
12	Darwin	Darwin	Darwin/Slate Range	None	150,000,000[2]	600.0	21
141	Marble Mountains	Marble Mountains	Marble Mountains	Minor	50,000,000[2]	200.0	21
98	Meevint	New York Mountains	New York Mountains	Some	42,000,000[2]	168.0	21
54	Mojave	Mojave	Soledad/Rosamond	24,700,000		98.8	
"	"	"	"		20,000,000+[1]	80.0	9
125	Oro Grande	Oro Grande	Stoddard	50,000,000		200.0	
"	"	"	"		100,000,000[1]	400.0	9
105	Piute Mountains	Piute Mountains	Piute Mountains	Minor	100,000,000[1]	400.0	21
"	"	"	"		300,000,000[2]	1,200.0	21
129	San Jacinto Mtns.	Banning Pass	Santa Rosa Mtns.	Unknown	100,000,000[1]	400.0	21
"	"	"	"		200,000,000[2]	800.0	21
97	Striped Mountains	Ivanpah Mountains	Clark Mountains	Unknown	100,000,000[1]	400.0	21
"	"	"	"		300,000,000[2]	1,200.0	21
169a	Waters	Fish Creek Mountain	Yuha Basin	None	100,000,000[1]	400.0	21
"	"	"	"		300,000,000[2]	1,200.0	21
39a	West End Quarry	Slate Range	Darwin/Slate Range	1,500,000		6.0	84
"	"	"	"		20,000,000+[2]	80.0	9
23	West End Quarry	Argus Range	Darwin/Slate Range	3,500,000		14.0	21
"	"	"	"		33,000,000[1]	132.0	21
"	"	"	"		100,000,000[2]	400.0	21
	Total Production			120,700,000		482.8	
	Total Reserves				653,000,000	2,612.0	
	Total Resources				2,174,000,000	8,696.0	

Oil and Gas

Uses: Petroleum products are used as fuels, in producing organic compounds and plastics, and as lubricants. Carbon dioxide is used for manufacturing dry ice and as a propellant in petroleum pipelines.

Consumption: In 1980, preliminary figures show that the U.S. consumed 6.22 billion barrels of crude oil, including approximately 1.90 billion barrels of imported crude oil. The U.S. also consumed 20.07 trillion cubic feet of natural gas that year, including 994 billion cubic feet of imports.

Trends: The demand for oil and natural gas has levelled off and is expected to decline by 7% in the next year.

Production: In 1980, the U.S. produced 3.15 billion barrels of crude oil and 20.15 trillion barrels of natural gas. California produced 346.5 million barrels of oil (Jim Campion, personal communication) and 333 billion cubic feet of gas that year. Carbon dioxide production from Federal land amounted to 0.28 billion cubic feet in 1978.

There has been no production of oil or gas in the CDCA. Only one area in the CDCA, the Imperial Valley, has produced gas in the form of carbon dioxide. The Sevier Overthrust Belt, a prolific oil and natural gas producing belt that extends from Alberta, Canada, to Baja, Mexico, extends into the CDCA. It includes the area from the Pahrump Valley to the Vidal Valley. Recent exploration activity suggests it may extend to the Big Maria Mountains before it enters Arizona. The flanks of the Imperial Valley are good natural gas prospects, based on historical drilling information.

Substitutes: Coal, nuclear fuels, oil shales, tar sands, and geothermal resources can be substituted for electrical power generation facilities. Automobile fuels are still based on oil, and there are few substitutes for petrochemicals in industrial applications.

Price: 1979 - $12.51 per barrel, crude oil.
$0.1178 per 1,000 cubic feet, natural gas.
$1.36 per 1,000 cubic feet, carbon dioxide on Federal land.

References: 14, 17, 39, 56, 57, 83, 6a.

OIL AND GAS PRODUCTION IN THE CDCA

Location	GRA	Potential
Pahrump-Ivanpah-Mesquite-Piute-Chemehuevi-Vidal Valleys (Sevier Overthrust Belt)	Kingston Range, Clark Mt., Homer Mt., Sacramento Mts., Stepladder Mts., Whipple Mts. Turtle Riverside Mts.	Good
Coachella-Imperial Valleys	Sulton Sea, Yuha Basin	Good
Fremont Valley	Red Mt.	Poor
Antelope Valley	Sierra Pelona, Adobe Mt.	Good
Lucerne Valley	Ord Mts. Bighorn Mts.	Moderate
Johnson Valley	Rodman Mts.	Poor
Milpitas Wash	Palo Verde Mt.	Poor

Sand and Gravel

Uses: Construction aggregate (concrete) 43%, road bases and coverings 22%, fill material 17%, asphaltic aggregate 15%, and railroad ballast 3%.

Consumption: The apparent U.S. consumption was estimated to be 988,000,000 short tons of sand and gravel in 1979. The U.S. exported an additional 2,076,000 short tons and imported 423,000 short tons of sand and gravel that year.

Trends: From a base year of 1976, the demand for sand and gravel is expected to increase at an annual rate of 1.6% through 1985.

Production: The U.S. produced 979,000,000 short tons of sand and gravel in 1979. California was the nation's leading producer, with 129,348,000 short tons, 13% of the total U.S. production. The CDCA produced approximately 4,708,160 short tons of sand and gravel during 1979. Most of this material was transported into the Los Angeles-San Diego metropolitan areas for construction.

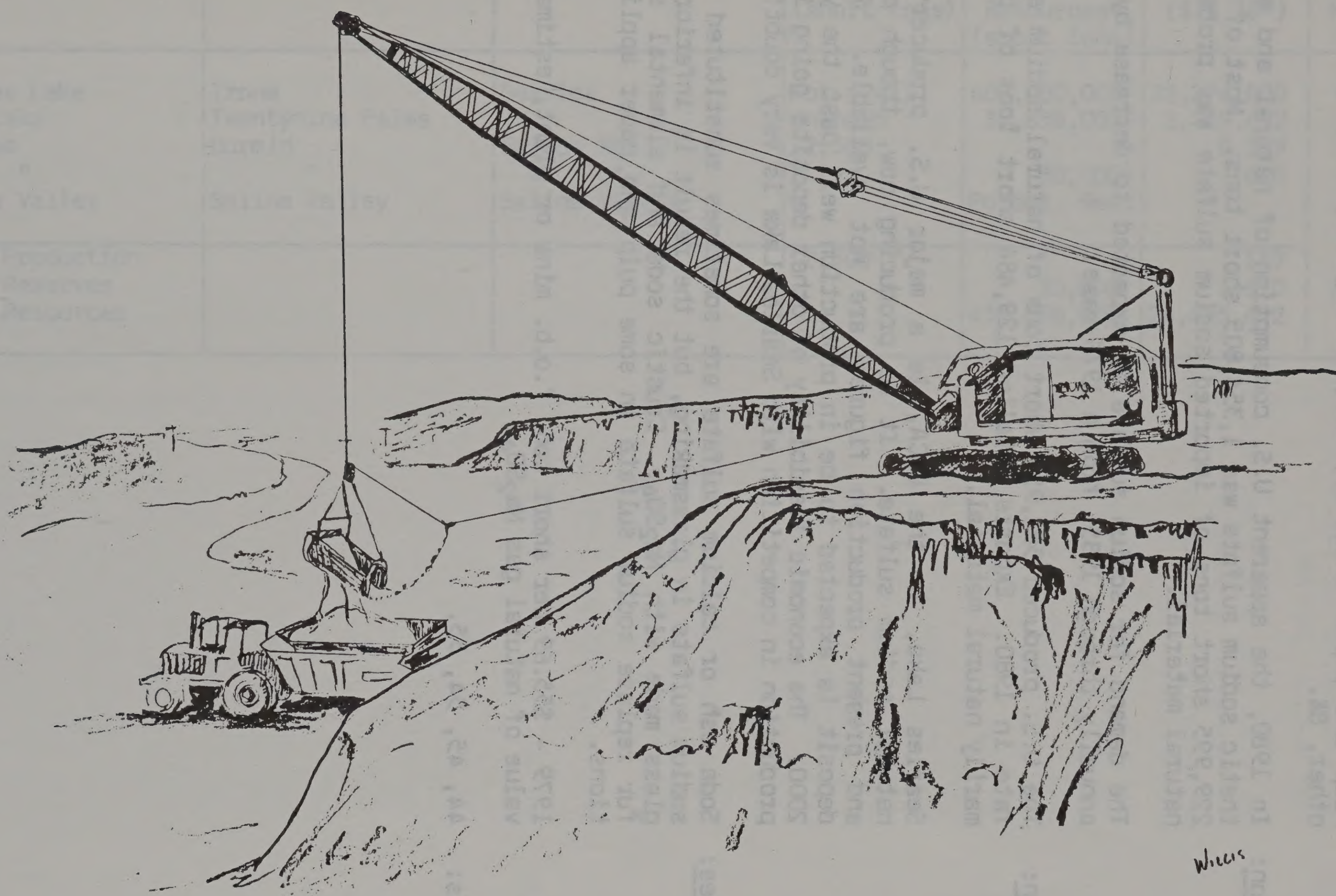
The CDCA has seemingly inexhaustable reserves of sand and gravel. However, the economics of sand and gravel require that the deposits be located close to the place of consumption. The major cost of concrete and aggregate is in transportation from pits to users. Based on data from the San Bernardino County Tax Assessor's Office, the per capita consumption of sand and gravel is 7.5 tons. That escalates to a requirement for 4,300,000 short tons per year in 1985 and 5,800,000 short tons per year in the year 2000. Based on these estimates, requirements for sand and gravel from the CDCA from 1980 to 2000 would total 99,400,000 short tons. As urban centers in southern California continue to expand, the CDCA will remain an important source of construction material.

There are numerous sand and gravel pits in the CDCA, many of which are intermittent producers. Due to the large number of pits and the large volume of this commodity in the CDCA, no list of deposits accompanies this report.

Substitutes: Crushed stone can be used in place of gravel but quarries are harder to reclaim than gravel pits. High purity sands for iron casting cannot be easily supplanted.

Price: 1979 - Approximate average, $0.25 per ton federal royalty.
$2.47 per ton f.o.b. at the mine commercially
($ average $2.52 in California).

References: 5, 54, 55, 75, 89.


Willis

Sodium Sulfate (Na_2SO_4)

Uses: Pulp and paper industry, 60%; detergents, 25%; glass, 7%; other, 8%.

Consumption: In 1980, the apparent U.S. consumption of natural and synthetic sodium sulfate was 1,354,805 short tons. Most of the 229,995 short tons of imported sodium sulfate was probably natural material.

Trend: The demand for sodium sulfate is expected to decrease by 2% annually through 1985, from a 1976 base.

Production: The U.S. produced 582,950 short tons of natural sodium sulfate in 1980. Exports totalled 129,484 short tons of primarily natural material.

Searles Lake, in the CDCA, is a major U.S. producer of natural sodium sulfate. It is producing now, though past and present production figures are not available. This deposit is expected to be in production well past the year 2000. The economic feasibility of other deposits going into production in competition with Searles Lake is very doubtful.

Substitutes: Soda ash or calcium sulfate are sometimes substituted for sodium sulfate in glassmaking, but the result is inferior to glass made with Na_2SO_4. Caustic soda and elemental sulfur replace sodium sulfate in some pulp and paper applications.

Price: 1979 - $55.69 per short ton, f.o.b. mine or plant, estimated value of natural gas Na_2SO_4.

References: 44, 45, 54, 55.

SODIUM SULFATE IN THE CDCA

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production (short tons)	Reserves[1] Resources[2] (short tons)	Value ($ X 10^6)	Reference Number
44	Searles Lake	Trona	Searles	Not avail.	400,000,000[2]	22,276.000	44
134	Dale Lake	Twentynine Palms		Unknown	39,858,000[2]	2,219.692	15
159	Bertram	Durmid	Salton Sea	2,500		0.139	62
"	"	"	"		30,000[1]	1.670	62
59	Saline Valley	Saline Valley	Saline Valley		Potent. Res.		15
	Total Production			2,500		.139	
	Total Reserves				30,000	1.670	
	Total Resources				439,858,000	24,495.692	

Zeolites

Uses: The principal uses of zeolites are as molecular sieves and ion exchangers in waste treatment facilities and in pollution control devices.

Consumption: The U.S. uses both synthetic and natural zeolites. Most of the domestic production of natural zeolites is presently consumed in research to determine future uses for these minerals.

Trends: The demand for zeolites may increase rapidly in the next decade because of increasing requirements for environmental protection equipment for air and water quality control.

Production: Zeolites are currently produced by Anaconda at Ash Meadows, in the CDCA. The annual U.S. production of natural zeolites is approximately 5,000 short tons. There is no set price for zeolites because there are not large markets for this commodity. As research into the uses of zeolites discovers ways to utilize this material, markets and prices will become established. The price given below is an estimated value obtained from a U.S. Bureau of Mines commodity specialist.

Substitutes: There are no known naturally occurring substitutes for zeolites. Synthetic zeolites are currently being used in ion exchange applications.

Price: 1980 - $125.00 per ton.

References: 20, 55.

Map -XIV- 2-1 No.	Deposit	Location	GRA	Production (short tons)	Reserves[1] Resources[2] (short tons)	Value ($\$ \times 10^6$)	Reference Number
27	Ash Meadows (C)	Death Valley Junct.	Pyramid	Unknown	20,000,000[1]	2,500.000	21
115	Hector (C)	Hector	Cady Mountains	None	1,000,000[1]	125.000	113
"	"	"	"		1,000,000[2]	125.000	113
62	Mud Hills (C)	Mud Hills	Calico Mtns.	None	625,000[2]	78.125	80
"	"	"	"		5,000,000[2]	625.000	80
74	Rest (P)	Shoshone	Resting Spring Rng.	None	300,000[1]	37.500	21
77	Shoshone (E, P)	Shoshone	Resting Spring Rng.	None	300,000[1]	37.500	21
"	"	"	"		1,500,000[2]	187.500	21
	Total Reserves				21,600,000	2,700.000	
	Total Resources				8,125,000	1,015.625	

C=Clinoptolite
P=Phillipsite
E=Erionite

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MINERAL INDUSTRY EMPLOYMENT IN THE CDCA

This section describes the extent of direct employment by the mineral industry in the CDCA. Mineral industry is defined as firms that explore for, mine, or process mineral materials. People whose livelihood may be related to the mineral industry, such as contract truckers, builders, and wholesale and retail sellers, are not directly employed in the mineral industry and are not included in the standard data sources as part of this industry. They are included in the indirect employment effects in economic analyses. The direct employment plus the indirect employment are the total employment attributable to the mineral industry in the CDCA. The impact is usually estimated through an input-output or economic base study. The conduct of such studies was beyond the constraints of the CDCA planning effort, so only rough estimates of indirect employment are given.

In some cases, employment at plants outside the CDCA is based on minerals mined inside the CDCA. Some such cases of substantial related employment are identified but not included in the total mineral industry employment in the CDCA.

The basic source on employment data is the 1979 reports of the State of California Employment Development Department (EDD). The mining sector reported by EDD covers most of the mineral industry in the CDCA, except cement manufacturing and calcining of gypsum. Employment in the latter categories has been estimated using the data obtained by telephone from processing firms located in the CDCA. Sand and gravel employment is included in the mining sector statistics reported by EDD, so it is not identified separately.

Employment is shown by county as much as possible. Though EDD data is reported for whole counties, no county falls entirely within the CDCA. As a result, the following rationale has been used to determine whether to use whole county data. San Bernardino and Riverside counties are aggregated because this is how they are reported by EDD. The cement manufacturing industry employment was estimated by counting the number of firms operating in the CDCA portion of each county and multiplying by the number of employees at a typical cement plant.

Kern, Imperial, and San Diego County mineral employment was estimated by calling major mineral industry firms in those counties for personnel figures.

Table XIV-2-9 shows the estimated mineral industry employment in the CDCA. The total of 7,932 is 4.1 percent of the estimated employment in the CDCA for 1979 (Table XIV-2-10).

It is reported that the California Mining Association (CMA) in 1976 listed 23,906 employees in six counties within the CDCA (San Bernardino Economic Development Department, May 15, 1980). Conversations with CMA representative Ray Hunter (June 25, 1980) confirmed such estimates but did not produce documentation of methodology. The data sources were said to approximate those used in this report, except they were for an earlier period. The difference may be due to the exclusion of oil and gas extraction employment in this study. Oil and gas employment occurs primarily in Los Angeles and Kern counties, outside the CDCA. Also, though the CMA estimate

is said to have omitted sand and gravel, it must have been included if EDD estimates were used. EDD reports include sand and gravel employment as part of mining under SIC 14 (Mining), (OMB, Standard Industrial Classification Manual).

Table XIV-2-9 shows that mineral industry employment is most concentrated in the San Bernardino County portion of the CDCA. It has been estimated that in the Victorville area, 13 percent of all employees and 36 percent of total private sector employment are in the minerals industry (County of San Bernardino, Economic Development Department, June 24, 1980).

While San Bernardino County has the largest employment in the mineral industry, Inyo County has the greatest dependence on mineral industry employment. Surveys of desert residents reflect this, with residents of the eastern half of the desert, including Inyo County, being most opposed to controls over the use of the desert. Part of the concern in this area stems from the controversy over continuing borate mining within Death Valley National Monument.

Table XIV-2-9
MINERAL INDUSTRY EMPLOYMENT IN THE CDCA (1979)

County		Persons Employed
San Bernardino and Riverside		
Mining (EDD, whole counties)		2,600
Cement (262 per plant) - 8 plants		2,096
	SUBTOTAL	4,696
Los Angeles (whole county)		
Mining (EDD) (oil and gas extraction excluded)		1,300
Inyo (CDCA share based on population)		
Mining and Manufacturing (EDD)		124
Kern (CDCA portion)		
Cement		1,250
Boron products		262
	SUBTOTAL	1,512
Imperial		
Gypsum products		300
San Diego (CDCA portion)		0
	TOTAL	7,932

Sources: State of California, Employment Development Department.
Telephone calls to mineral producers in the CDCA.

Table XIV-2-10
CDCA MINERAL INDUSTRY EMPLOYMENT
AS A PERCENT OF TOTAL CDCA EMPLOYMENT (1979)

County	CDCA Employment*	Mineral Industry Employment	Percent
San Bernardino	42,400	4,696	11.0
Riverside	59,900	4,696	7.8
Los Angeles	32,500	1,300	4.0
Inyo	1,100	124	11.3
Kern	20,300	1,512	7.4
Imperial	35,250	300	0.9
San Diego	650	0	0.0
TOTAL	192,100	12,628	6.6

* Total employment for CDCA portions is taken from SRI, Future Demographic and Economic Trends in the California Desert, October 1978.

INDEPENDENT MINES IN THE CDCA

The independent miner is a person who works part or full-time prospecting for minerals or operating mines, but is not employed by one of the large corporate mineral firms. Typically, the independent miner is self-employed or works for a firm employing five or fewer people.

A separate section is devoted to independent miners for three reasons: independent miners are reported to be responsible for finding most major mineral deposits that have been developed; their life style is distinct, in addition to providing employment and income; these people are not reported in standard employment statistics because they usually are not covered by employment compensation insurance.

Since there is little hard statistical data on independent miners, estimates of their numbers are necessarily imprecise. It is estimated that there are 300 to 500 independent miners in the CDCA. The number of mineral producers in the CDCA counties has been conservatively estimated at 318 (San Bernardino County, June 30, 1980).

The key ingredient for the continuation of this life style is the opportunity to prospect over large areas having mineral potential and to capitalize on the results by obtaining title to valuable deposits thus located. This opportunity is provided largely by the Mining Law of 1872, which applies to public lands not withdrawn from mineral entry.

The independent miners are motivated, in part, by an affinity for desert living with its freedom from urban interference and partly by the hope of someday finding a valuable deposit. The latter motivation is currently being fueled by the rapid escalation of worldwide mineral prices. Deposits that were uneconomical to develop at past prices may become operable as mineral prices escalate. Old gold and silver mines in the CDCA are reportedly being considered for renewed production. Many of these mines were closed by Presidential order during World War II because they were nonessential employers.

Independent miners generally feel threatened by the current trend of increased Federal, State and local regulation of mining activities. The effect of these regulations is to increase the cost of exploration and mining. Another perceived Federal threat is the potential establishment of wilderness areas. The first step, designation of wilderness study areas, limits the production of existing mines and substantially increases the paperwork required for intensive exploration and development of new discoveries. The next step, Congressional designation of wilderness, is perceived as being particularly threatening because it may permanently prevent production from unpatented claims that miners have been actively working.

The independent miner's tie to the major mineral producing firms is through the sale or lease of mining claims. Usually, the independent miner lacks the capital to fully explore and develop deposits. If the market looks healthy, large firms frequently buy the more promising claims for selected minerals and carry out an intensive program of exploration, resulting in the opening of a new major production site.

SIGNIFICANCE OF THE MINERAL INDUSTRY IN THE CDCA

This section is concerned with the linkage between the mineral industry in the CDCA and the rest of California, the United States, and the world. Only the most prominent linkages are cited; for a more complete commodity-by-commodity discussion, the reader is referred to the "Commodity Reports" portion of this appendix.

Kaiser Steel

The nation's largest steel mill west of the Mississippi River, Kaiser Steel is located at Fontana, in western San Bernardino County. Though this mill is outside the CDCA, it is completely dependent upon the supply of raw materials from the CDCA for its operation. The raw materials involved are iron ore from the Eagle Mountain mine in the Riverside County portion of the CDCA and smelter grade limestone from the Cushenbury Springs area of San Bernardino County. Employment at the mines has been included in the CDCA employment data. An additional 7,600 people are employed at the mill in Fontana. The main competitor with this plant is steel imported from Japan.

Union Oil-Molycorp

Located at Mountain Pass in eastern San Bernardino County, the Union Oil-Molycorp mine and plant supply over half of the world's supply of rare earth minerals. These minerals are used throughout the United States in the production of petroleum (catalysts), iron and steel (including pyrophoric alloys), ceramics and glass, and electronics (color TV tubes and X-ray screen intensifiers).

U.S. Borax

The U.S. Borax mine and plant located at Boron in eastern Kern County is the world's largest producer of boron minerals. It employs about 1,250 people, and further expansion is expected in the near future. Most of the boron minerals are used in the north-central and eastern states to manufacture glass, soap and detergents, and other chemical derivatives. Their use in high temperature glass cannot be substituted without significant reduction in quality. This company is probably the largest nongovernment employer in the CDCA.

Kerr-McGee

The nation's second largest producer of boron products, Kerr-McGee also produces sodium carbonate products. The plant is located at Searles Lake in eastern San Bernardino County. The mineral source is the brines taken from the lake. A great variety of products are produced from a highly integrated plant. The brines in this lake constitute the nation's largest reserve of tungsten, now an additional product of the plant. The market for this plant's varied products is nationwide.

U.S. Gypsum

The U.S. Gypsum quarry and processing plant are located in western Imperial County. Calcined gypsum produced there is used for wallboard, plaster, and in the production of cement. The market is primarily the building industry throughout the western states. Approximately 300 people are employed at the plant.

Cement Manufacturing

Essential to the building industry, cement is manufactured by eight firms in the CDCA. These firms quarry limestone and process it for sale as lime, limestone, and cement. Part of the production from these facilities goes to the Kerr-McGee plant at Searles Lake where it is used to produce carbon dioxide. Another major mineral producer dependent upon these quarries is Kaiser Steel, which obtains the lime necessary for its smelters at Fontana. The market for these products is principally southern Califonia. At this time, some cement is being imported to the Port of Los Angeles from foreign sources because of increasing costs of domestically produced cement. The

CDCA will have to be the source of most of the cement used for future building in southern California. A large new limestone quarry and cement plant is expected to be opened soon in western Imperial County. Current CDCA employment in the industry is estimated to be 2,400 people.

MAJOR MINERAL PRODUCERS IN THE CDCA

Existing Mineral Producers

American Borate -- Boron minerals from the Billie Mine in Death Valley National Monument, Inyo County, and the Maria deposit outside of the Monument.

Pfizer -- Talc from a mine in Death Valley National Monument and a mine east in Inyo County.

Cyprus -- Talc from a mine in Death Valley National Monument; all of the talc mines send mineral to be milled at a plant between Barstow and Baker.

Creal -- Cement and limestone near Mojave in Kern County; California Portland Cement Co.

Victorville -- Cement, gypsum, limestone, stone from Riverside Cement Co., Southern Portland Cement Co., Pfizer Co. at Victorville, San Bernardino County.

Cushenbury Springs -- Area contains four plants supplied primarily from limestone quarries in the San Bernardino National Forest; Pluess-Staufer, Pfizer, Kaiser, Partin Limestone.

Westend Quarry -- Argus Range; limestone source for Kerr-McGee's Searles Lake plant.

Proposed Mineral Producers

Plaster City, Imperial Co. -- Large cement plant and mine to be constructed by Texas Industries; expected employment, 200.

Piute Limestone-Pleuss-Staufer Inc. -- Soon to develop a limestone quarry near Essex; may be processed at existing plant site in Lucerne Valley.

Calico -- Barite and silver source, to begin operation in 1983 (possibly) by ASARCO; $100 million to build mill.

Barstow -- Occidental Minerals proposes to develop a zeolite deposit; area has been drilled, would be an open pit operation.

Ash Meadows -- Anaconda is producing and plans to produce zeolites from a new mine southeast of Death Valley Junction.

Highly Probable Production Areas

Yellow Aster Mine -- Randsburg, high probability of being reopened by ASARCO.

Kelly-Rand Silver Mine -- in Red Mountain; underground exploration continuing in existing tunnels.

Red Hill -- Molybdenum deposit in Ord Mountains southeast of Barstow; being explored by B&B Mining (subsidiary of Noranda).

Northeast of Last Chance Mountain -- Molybdenum deposit being explored by Marathon Oil.

Clark Mountain -- Colosseum Mine being explored by Draco Co. to confirm size of gold deposit; will probably evolve into an open pit mine.

Sentinel Peak Mine -- Panamint Range deposit of uranium and silver; being explored by Lacana Joint Venture.

Coso -- Uranium deposit just outside of the Naval Weapons Center; being explored by several companies: Rocky Mountain Energy, Federal Resources Corp., Phillips Uranium Corp.

Copper Basin Deposit-Whipple Mountains -- Relatively small copper deposit compared to deposits in Arizona; ore grade rock at current prices; Louisiana Land and Minerals has delineated the deposit.

Gerstley Mine-U.S. Borax -- Borate mine northeast of Shoshone; ore body delineated; intermittent production for last 60 years; in Inyo County.

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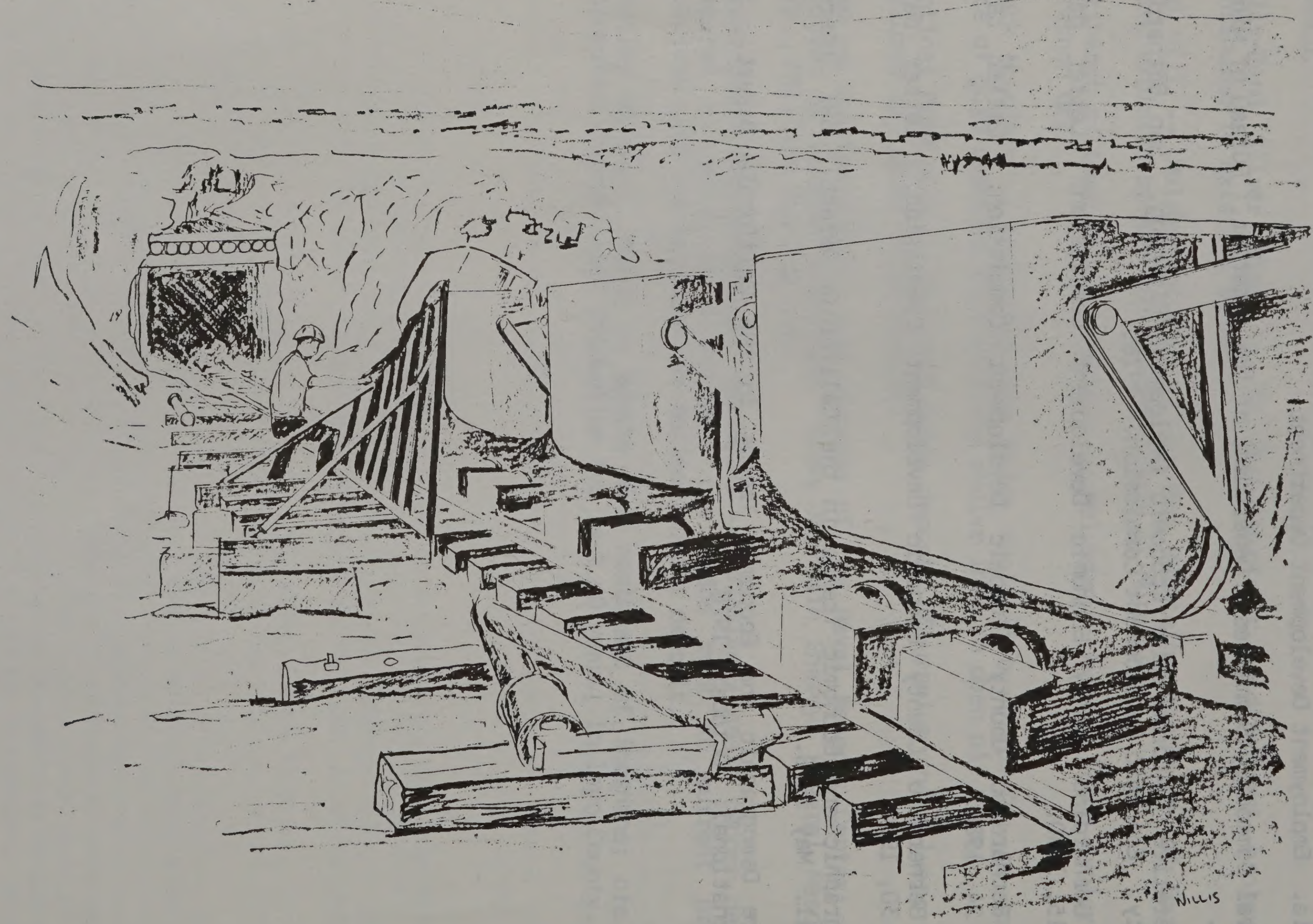
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Part 3

Surface Disturbance and Reclamation Related to Mining

This section is intended to document the present state of mining-related surface disturbance in the CDCA and to project the estimated additional surface disturbance over the 20-year life of the California Desert Conservation Area Plan. It also explains the type of mineral activities that have occurred or will occur in the CDCA. These scenarios were put together by several Bureau mineral specialists and by a BLM contract to Omniplan Corporation (June 1980), which evaluated the potential impacts of six hypothetical mining operations in three different ecosystems of the CDCA. These scenarios are intended to serve as reference material for the assessment of the effects of these operations on the environment.

Mining has occurred in the CDCA from the 1860s to present. In 1974, the U.S. Bureau of Mines published statistics, by state, on all lands disturbed and reclaimed by surface mining activities. This report formed the baseline for the following analysis of the effects of mining in the CDCA. In addition, the soils specialist on the Desert Plan Staff, using recent (1973-77) aerial photography, compiled a preliminary inventory of areas disturbed by mining operations, exclusive of the roads into these operations.

Table XIV-3-1 presents the mining disturbance projections in two columns labelled "High" and "Low." The "High" column contains figures based on the U.S. Bureau of Mines baseline data. The Desert Plan Staff analyzed the effects of suface disturbance on various resources based on the figures in the "High" column. The "Low" column was calculated using the aerial photo data as a constant base in 1980 and was projected to the year 2000. These two columns, therefore, define the anticipated range of surface disturbance in the CDCA over the next 20 years. Based on the aerial photo inventory, the CDCA has lagged behind the State as a whole by about 24 percent in acreage disturbed by surface mining activities. The CDCA has not had the same level of mineral development as the rest of the State.

The reclamation data are derived from statewide baseline data because there are no separate figures on reclamation solely for the CDCA; only statewide totals are available. The State Mining and Reclamation Act of 1975 and the Title 43 Code of Federal Regulations subparts 3802 and 3809 require ongoing reclamation of mined lands. The rate of reclamation has increased markedly since these acts went into effect. However, statistics are not yet available for projection. Therefore, projected reclamation figures in Table XIV-3-1 are minimum values. The actual acreage reclaimed will be higher.

It should be noted that of the 18,031,000 acres open for mining in the CDCA, 64 percent is administered by the Bureau. The remainder is State or private land. It is impossible to separate the areas of potential effects from mining by land ownership. Therefore, this analysis covers the CDCA as a unit and considers all lands jointly.

Table XIV-3-1

PROJECTED MINING DISTURBANCE IN THE CDCA 1/

Land Status		
State of California, total acreage	100,207,000	
Acreage in the CDCA open to mining	18,031,000	
Percent of the State of California in the CDCA and open to mining	17.99%	
Past Disturbance		
State of California		
Acreage disturbed by mining, 1930 to 1971 (42 years)	227,000	
Acreage disturbed by mining, calculated to 1980 (227,000/42) X (50)	270,238	
CDCA		
Acreage of expected disturbance calculated to 1980 from historical statewide trends (270,238) X (0.1799)	48,616	
Acreage of actual disturbance compiled from aerial photographs to 1980 (includes 20% inflation for roads and missed mines)	37,031	
Difference between calculated and actual acres	11,585	
Difference between calculated and actual acres in percent	23.83%	
Projected Disturbance	**High**	**Low**
Calculated annual disturbed acreage in California from 1980-2000		
(270,238 acres/50 yrs) X (0.1799)	972	
(270,238 acres/50 yrs) X (0.1799) X (0.7617)2/		741
Calculated total mining disturbance in the CDCA from 1980-2000		
(972 acres) (20 years)	19,446	
(741 acres) (20 years)		14,812
Additional roads at 10%	1,945	1,481
Total	21,391	16,293

Table XIV-3-1 (continued)

PROJECTED MINING DISTURBANCE IN THE CDCA 1/

Projected Disturbance	High	Low
Expected rate of increase in mining activity is 13%	2,781	2,118
Total projected disturbance	24,172	18,411
Total projected disturbance as a percent of CDCA open to mining	13%	10%

Reclamation 3/	HIGH (ACRES)	LOW
Reclamation in California from 1930-1971 (42 years)	43,900	43,900
Reclamation acreage calculated to 1980 (all CA) (50 years)	52,262	52,262
Calculated acreage reclaimed in the CDCA to 1980	9,402	7,161
Calculated annual rate of reclamation to 1980 (CDCA)	188	143
Projected acreage to be reclaimed from 1980-2000	3,760	2,864

1/ Baseline period, 1930-1971 is 42 years (Paone, Morning, Giorgetti; Land Utilization and Reclamation in the Mining Industry, 1930-71 U.S. Bureau of Mines Information Circular IC 8642, 1974).

2/ This correction factor adjusts statewide disturbance acreage to observed CDCA acreage. It was derived by subtracting 23.83 percent (the difference between calculated and actual acres) from 100.

3/ The projected reclamation acreage does not take into account the Bureau's surface management regulations (43 CFR 3802 and 3809) or CDCA Class guidelines. Actual reclaimed acreage will be higher.

Table XIV-3-2 gives the location of the major mining operations in the CDCA by commodity, method of mining, and acres disturbed. Data were compiled from the aerial photo inventory.

The three largest operations are at Boron (open pit for borates), Eagle Mountain (open pit for iron), and Searles Lake (solution mining for saline minerals). On a desertwide basis, the limestone, gypsum, and sand and gravel operations disturb larger areas than other types of mining.

The following scenarios will give the reader a good perspective of the types of mining activites that occur within the CDCA and some of the details of the internal workings of these operations. These scenarios are not meant to depict any particular mining operation. They are simply examples of such operations. The previously mentioned report by Omniplan Corporation provides a fuller understanding of the effects of mining operations in the CDCA. Table XIV-3-3 is a summary of the surface disturbing activities as outlined in the Omniplan report and the costs of exploration, development, and reclamation activities in the CDCA. This report is available for viewing at the BLM offices in Riverside and Sacramento.

LOCATABLE MINERALS SCENARIO

At any given time, minerals activity in the California Desert could include any or all of the following: numerous small lode operations for gold and other metallic minerals; larger subsurface operations for disseminated metallic minerals and industrial minerals; numerous small to moderately large (to 50 acres) open-pit operations for industrial minerals and metallic minerals; a few large, open-pit operations on the order of 500 acres or more; and numerous smaller placer gold operations. Operational life can vary from a few intermittent months for small placer and lode operations to 5 to 30 years or more. Different mineral occurrences may require particular methods of detection and exploitation. With all these variables, there are still some common environmental effects from activities during the progressive stages of mining.

Tables XIV-3-4 through XIV-3-7 summarize the type and extent of activities involved in the exploration, development, extraction, and reclamation phases of mining for locatable minerals. A more detailed discussion follows the tables.

Table XIV-3-2

MAJOR MINING OPERATIONS IN THE CDCA

COMMODITY	LOCATION	MINING METHOD	ACRES USED
Borates	Boron	Open Pit	2,320
	Ryan Area	Open Pit	120
			2,440
Iron	Eagle Mountain	Open Pit	4,630
Limestone and Gypsum	Black Mountain	Open Pit	320
	Oro Grande	Open Pit	920
	Victorville Area	Open Pit	150
	San Bernadino Mts.	Open Pit	1,270
	Tehachapi Mountains	Open Pit	490
	Big and Little Marias	Open Pit	555
			3,705
Rare-Earths	Mountain Pass	Open Pit	660
Talc	Kingston Mountain	Open Pit	195
	Ibex Hills	Underground	45
			240
Clay	Hart Mine	Open Pit	130
Sand and Gravel	CDCA-Wide	Open Pit	6,700
Saline Minerals	Searles Lake	Solution Mining	6,415
	Koehn Dry Lake	Solution Mining	130
	Bristol Dry Lake	Solution Mining	2,130
	Danby Dry Lake	Solution Mining	250
	Cadiz Dry Lake	Solution Mining	290
	Dale Lake	Solution Mining	310
			9,525
Base and Precious Metals (Au, Ag, W, Cu, Pb, Zn)	Johannesburg Area	Open Pit	1,120
	Red Mountain Area	Underground	350
	Randsburg Area	Underground	185
	Summit Range	Underground	33
	Revenue Canyon	Open Pit	35
	Whipple Mountains	Open Pit	270
	Savahia Peak	Underground	19
	Ivanpah Mountains	Underground	66
	Vanderbuilt Mine	Underground	54
	Calico Area	Underground	407
	Darwin Area	Underground	90
			2,629
Total Acreage Inventoried			30,659

Table XIV-3-3

ESTIMATED EXPLORATION, DEVELOPMENT, AND RECLAMATION COSTS OF MINING ACTIVITIES IN THE CDCA

ACTIVITY	Limestone Quarry I	Pb-Zn-Ag Mine II	Clay Pit Bentonite III	Open Pit Copper IV	Solution Mining Uranium V	Solution Mining Brines VI
EXPLORATION[1]						
Cost[2]	$.1	$2	$1	$15	$10	$10
Roads (acres)	1-3	1-2	5	5	1-3	1-3
Pads (acres)	3-5	1-3	3-5	4-5	2-3	2-3
DEVELOPMENT[1]						
Roads (acres)	121	30	181	15	121	121
Powerlines (acres)	87	15	58	8	87	87
Mine Site (acres)	1,500	---	200	1,500	200	200
Mill Site (acres)	---	200	---	---	5	5
Tailings (acres)	1,500	100	100	1,500	200	200
Mill Cap. (tons)	20,000	1,000	3,000	25,000	1,000	1,000
Water Use (gals)	40,000	10,000	6,000	250,000	large	large
Mine Life (yrs)	10-20	20	10	20-40	10	20
Employment	100+	200+	100+	500+	150+	150+
Acres Used	3,200	345	540	3,000	613	513
Capital Cost[2]	$6.1	$14	$9.1	$60	$20	$25
RECLAMATION[3]						
Cost Per Acre	$1500-2000	$200	$4000	$1000-6000	$1000	$1000
Company Cost	$4.8 to $6.4	$.069	$2.16	$3 to $18	$.613	$.513
Total Project	$11 to $12.6	$16.069	$12.26	$78 to $93	$30.613	$35.513

1 Omni-Plan 1980.

2 Dollar amounts expressed in millions in 1979 dollars.

3 National Academy of Sciences, 1979.

Table XIV-3-4

EXPLORATION: HARDROCK MINING

TECHNIQUES[1]	Duration	Area Involved	Access Needs	Air/Water Impacts
Geologic (outcrops), geophysical, geochemical prospecting of broad areas.	Several weeks to one year.	Broad areas, intensity comparable to recreation use (hiking).	Existing access.	Negligible
Trenches, pits exploration headings (adits, shafts) on a narrowed target area.	Several weeks to a few months.	Less than 10 acres. The intensive use of working and waste dumps.	Existing access and minor additional developed access for light vehicles.	Minor intermit-tent dust.
Drilling of a target area.	Several weeks to several months.	A few drill sites within 20 to 1,000-acre target area.	Existing access and development of light to heavy vehicle access.	Minor intermit-tent dust. Possible drill fluid residues.

[1] Activities are listed sequentially. Some steps may be omitted by early discovery of mineralization.

Table XIV-3-5

DEVELOPMENT: HARDROCK MINING

TECHNIQUES, ACTIVITIES	Duration	Area Involved	Air/Water Impacts
Development drilling	5 to 10 months (overlaps and continues exploration drilling).	Drill sites and their access within 20-500 acres.	Minor, intermittent dust. Possible drill fluid residues.
Surface Mining:			
Removal, placement of overburden.	Several months to 2 years.	Several hundred acres.	Dust, intermittent.
Initial development of pit working faces (a series of benches).	Several weeks to a year.	Within above area.	Dust, intermittent.
Subsurface Mining:			
Development of underground access preparing to extract, haul, or hoist ore and waste.	Less than 1 year to 2 years.	Small portal area.	Minor dust. Possible water discharge from subsurface workings.
Construction of surface plant (to crush, grind, upgrade ore).	1 to 2 years, (concurrent with above).	5 to 100 acres.	Dust.
Construction of surface access (roads, railroads, overland conveyors).	A few months to 1 year (concurrent).	About 5 to 10 miles, 5 to 6 acres per mile.	Dust.
Utilities development; water (wells, reservoirs, pipelines); electricity (transmission lines, pipelines).	Several months to 1 year (concurrent).	Together with access roads.	Dust.

Table XIV-3-6

EXTRACTION: LOCATABLE MINERALS

TECHNIQUES, ACTIVITIES	Duration	Area Involved	Air/Water Impacts
Surface Mining: Open pit, advancing downward on a series of benches. Pit slopes to about 40° - 50°.	5 to 30 years or more.	Up to 500 acres or more, to perhaps 1,000 feet deep.	Dust.
Subsurface Mining: Vein mining to block caving of large, low-grade deposits.	5 to 30 years or more.	None additional (see mine waste disposal below).	Possible water discharge.
Milling operations.	Mine life.	5-100 acres for the mill area.	Fluid and gaseous effluents.
Mine waste disposal (may involve heap leaching of low-grade ore).	Mine life.	5-500 acres	Dust, leaching fluids.
Mill tailings disposal.	Mine life.	5-2,000 acres	Mill fluid residues.

Table XIV-3-7

RECLAMATION: LOCATABLE MINERALS

TECHNIQUES, ACTIVITIES	Duration	Residual Effects
Dismantling, salvage of surface plant.	Several months to one year.	Compacted areas, concreted area.
Reduction, and/or fencing of dangerous pit slopes.	Several months.	Some degree of hazard may remain.
Blocking or sealing of undergound access.	A few weeks to several months.	Few effects at portals. Subsidence at block-caved areas.
Neutralization, removal, containment of toxic residues.	Several weeks to months. Periodic monitoring.	Reduced vegetative productivity.
Grading, shaping of waste dumps, mill tailings to blend into surrounding terrain.	Several months.	Degraded visual aspect as a permanent effect.
Development of lakes, ponds from pit areas where practicable.	Several months.	Most pit areas remain as a permanent effect.
Revegetation as practicable.	Short operations within a one to two year period.	Probable reduced vegetative produc-tivitiy.

Lode Mining

Exploration

Initial on-the-ground exploration techniques include geological and geochemical surveys, most involving light vehicle access or foot traverses with portable equipment. These activities cover broad areas with use intensity and effects comparable to recreational touring and hiking.

If anomalies or mineral showings are found, exploration may proceed with an increasing need for subsurface deposit data. This may involve surface cuts, then short adits and/or shafts in conjunction with a few drill holes. For large, low-grade metallic or industrial mineral deposits, the work might consist of trenching and successive drilling patterns aimed at identifying and outlining the deposit. Exploration headings (adits or shafts) may be driven to confirm drill-hole sampling and to develop bulk samples for metallurgical (ore processing) testing. If the evaluation determines economic feasibility of mining, development may begin.

A series of minor (surface) trenches, pits, and cuts can be completed within a few weeks. Adits and shafts can take up to several months to complete, with development proceeding at a rate of perhaps 5-10 feet per day. The areas affected are the actual surface exposures of the workings and their dumps, perhaps averaging 20 by 30 feet (0.01 acres) each, and their access (about 2 acres per mile), so that surface effects would rarely exceed 5-10 acres within the several hundred-acre target area.

Surface effects from drilling involve access (about 2.5 acres per mile) for drills on medium to heavy duty trucks and drill pads of from 15 by 15 to 30 by 30 feet (0.005 to 0.02 acres) each. For example, drilling 640 acres on a 500-foot grid would involve less than 2 acres in drill pads and about 15 to 20 acres in access. If water is used to raise drill cuttings, alkaline mud conditioners (dispersants such as sodium tetraphosphate) may be used. Small amounts of petroleum may be used to lubricate the drill column. Drilling rates would vary from about 35 feet per day for diamond drilling in hard rock to several hundred feet per day with rotary drilling in sediments. The duration of the drilling program would be from a few weeks to several months using several crews.

These activities would produce minor intermittent dust from vehicle travel and other surface operations. While these activities are more or less sequential, some of them may be omitted by discovery of an ore deposit at an early stage.

Development

A drilling program would continue into the development phase, within the existing drilling grid, to refine information on the deposit for design of the mining and possibly a milling program. Drill pattern and intensity would depend upon homogeneity of the ore. Erratic mineralization would require closer sampling intervals. For the 640-acre example, filling in the 500-foot drilling grid to a 100-foot grid would increase the surface disturbed by access routes by an additional 20 acres to a total of 30 to 40 acres and would increase the surface disturbed by drill pad areas to a total of 15 to 20 acres. Drilling may involve use of alkaline drilling

muds and petroleum lubricant for the drill column. Duration may be from several weeks to several months.

Surface development (open-pit) operations would involve stripping the overburden and developing initial benches or working faces. The materials may be piled nearby or used to construct tailing ponds if milling is involved or may be piled on impervious pads for leaching of minerals. Overburden, which may be useful later for reclamation, is usually stored separately at the site. Removal of overburden may require up to two years for the large open-pit copper mines. Development of pit benches may take a few weeks to a year for large pits. Areas identified in the current mining plan are the limits of the pit, ranging from approximately 20 to 50 acres to upwards of 500 acres. The operations would produce moderate to high intermittent dust from stripping and blasting.

Subsurface development in lode mining or large scale subsurface methods such as block caving involve development of subsurface access and facilities for extraction, storage, and hoisting of ore and waste. Development may take up to two years depending on mine size and mining method. Surface effects would be limited to the small areas of access to subsurface workings and the initial waste dumps. Pumping and water discharge problems would be minor in desert areas.

Surface facilities may consist of offices, assay or testing labs, warehouses, maintenance shops, and possibly a mill. Mills are crushing and grinding facilities for the separation and concentration of ores by washing and sorting, gravity methods (jigs and tables), heavy media separation, air flotation, or cyanidation. Surface facilities can vary from a few acres in small vein mines to 20 to 30 acres for larger mines to 100 acres for a large open-pit mine.

Access to the mine has a greater effect on the area outside the mine site than within the immediate mine area. Surface access within the mine area would occupy small areas within intensive use areas. Access to the mine may require extending existing routes by as much as 5 to 10 miles. Construction of paved roads or rail access could take several months to a year. Utilities (water, power, gas) would likely follow the same access route during the same construction period. Access and utilities may occupy up to 6 acres per mile depending upon terrain (rough country would produce widened cut and fill areas). Water storage reservoirs may occupy one to several acres near the surface facilities. There would be intermittent, moderate generation of dust during activities involved in surface development and construction.

Extraction

Open-pit mining involves advancing downward on a series of benches from the perimeter, steepening the average pit slope (through benches) as the final pit dimensions are reached. Final pit slopes may range from 25 to 50 degrees depending on competency of the rock. Duration of mining could be from about 5 to more than 30 years, covering the same surface area previously involved in target exploration and development activities (a few acres to 50 to 500 acres or more for a large open-pit mine). The effects would be intensive, involving cycles of blasting, loading, and hauling with accompanying dust and gases.

Subsurface mining effects on surface disturbance could be minimal, with intensive use at portal areas. Block caving effects may vary from nothing for deeper deposits to subsidence and funneling of surface materials into the center of the caved area. This would be the area already subjected to intensive exploration and development.

Effects from milling operations may range from minor dust to residues and gases from flotation and cyanidation processes. Flotation involves the use of water and several pounds of various organic and mineral oils, acids, and alkalies and various flocculants such as calgon. These are consumed to some extent and are also contained within ore concentrates and as residues in the tailings. Cyanidation is used to recover gold, and sometimes silver, by dissolving a weak solution (about one pound per ton of water) of sodium or calcium cyanide with solutions recirculated for reuse. Tailings are given a final fresh water wash to extract the greatest possible values but may still contain minor cyanide residue.

Mine waste may be spread over disposal areas or used to construct a tailings dam. In the case of copper, gold, silver, and possibly uranium ores, the waste may be leached by dumping on impervious pads (asphalt or butyl plastic) and treating them with weak acids (copper and uranium) or cyanide solutions (gold and silver). Waste dumps may vary from less than 5 acres for small mines to 500 acres or more for a large open-pit mine.

Mill tailings are dispersed as a series of tailings settlement ponds behind dams. As the materials dry, they may blow, depending on wind conditions. The tailings may contain residues of alkaline flotation reagents or sodium cyanide. Tailings areas may range from a few acres for small vein mines to as much as 2,000 acres for large open-pit mines.

Reclamation

At the end of the mining operation, the affected areas are rehabilitated and reclaimed for hazard abatement and the restoration of productivity to the disturbed lands. Surface facilities can be dismantled and salvaged over a period of several months to a year. Residual effects may be left in areas that were graded, compacted, or concreted.

For surface mines, hazardous slopes may be reduced (not practicable in hard-rock open pits) or fenced at their crest. Larger pits would remain as a residual effect.

Access to subsurface workings would be blocked and sealed over a period of weeks or months. For small mines, there may be few residual effects, largely confined to portal areas. For block caved areas, subsidence would be a residual effect.

Mine waste and tailings can be graded and shaped to blend more naturally into the surrounding terrain. Mine tailings can be neutralized and revegetation atempted. Residual effects would be degraded visual aspect and probable reduced vegetative productivity. Many aspects of rehabilitation can be accomplished during mining by the mining plan, by planned waste and tailing placements, and by commencing rehabilitation on abandoned areas during the life of the mine.

Placer Gold Mining

Operations would be generally small, 5 to 10 acres or less, with a few larger operations on low-grade deposits such as residual, colluvial, or floodplain deposits (as at Glamis) on perhaps 30 to 50 acres.

Exploration would involve effects of direct physical sampling through test pits, cribbed shafts, and auger or drill holes and would require temporary access. Net areas affected would be quite small, usually less than one or two acres.

Development and mining tend to merge in smaller placer operations. Mining may commence with bulk sampling and then proceed using similar processes. The most efficient separation requires water, which is impractical in most desert areas. Dry processes have poorer gold recovery and may generate considerable dust. The areas mined might range from a few acres to 10 acres and perhaps 20 feet deep to 50 acres of 30 or more feet in depth.

Placer mining has potential for restoration as mining proceeds. Mined gravels can be replaced, graded, and revegetated with little loss in productivity.

Lode Gold Mining

Because of the expected continuation of high gold prices, prospecting is occurring in many areas where gold may be found. The CDCA has a long history of gold mining and can expect its share of activity.

Large gold mines are possible in the CDCA, both as open-pit and underground operations. Small mines should be much more numerous. Exploration programs by large companies may find ore bodies too small to interest them, though the deposits may be profitable to the small investor. Independent prospectors may make new finds, although this may be rare in the CDCA. Old mines of known history, shut-down during World War II and low gold prices, may reopen. Prospects without a production history may be reexamined by government investigators and private explorers, and some should prove capable of profitable production.

Small gold-bearing veins are not uncommon in the geologic settings found in the CDCA. Although their values excite amateur gold seekers, the amount of gold is usually small compared to the quantity of barren rock mined to extract gold-bearing material on a continuing basis. Also, few amateur miners have the time, money, or knowledge needed to properly sample ahead of their mining and cannot anticipate when gold veins they are attempting to follow may come to an end. Historically, these uncertainties have not discouraged prospectors from wanting to "strike it rich," so the greatest threat of impact from gold mining may be the "gold fever" urge to rush out to the desert and start digging. In such instances, access roads and poorly planned bulldozing and trenching could severely tax BLM's ability to monitor these activities and keep them within reasonable and constructive bounds. Areas of the desert that once were blanketed with mining claims may see revived flurries of claim staking.

Underground mining methods generally require little surface disturbance, and some mining methods utilize waste material to fill in the voids created by mining so that surface waste dumps are small. A typical mine could occupy less than five acres. An additional 10 acres to 40 acres could be occupied by ore heaps used for the gold recovery.

Today, large operations use leaching methods for recovery wherever possible. They require up to several hundred acres for dumps to handle waste rock and for water-recovery systems. Leaching in-place does not require crushing and grinding the ore. Heap leaching on the surface may require crushing but not fine grinding. Recovery of low unit values in large operations usually requires fine grinding in a mill, with additional steps for dissolving and recovering gold and other associated minerals.

The common chemical agent for gold recovery is cyanide, a poisonous substance that must be carefully controlled. Cyanide is usually complexed as a sodium-zinc compound (which is recycled) or as an iron compound (which is disposable). Iron cyanide is not considered hazardous, but its disposal is carefully controlled by Federal and State regulations. Hydrogen sulphide can also be produced during the chemical processes for recovery of dissolved gold from cyanide solutions. Barren mill waste, similar to very fine sand, can be used as fill in underground mines or spread in waste dumps. For large operations, waste dumps can occupy more than 100 acres.

Surface facilities for small mines are simple and require little land; for large mines, subsidiary facilities, such as improved roads, electric power supply, etc., can require substantial land. If large electrical earth-moving equipment is needed for stripping overburden, up to 35 Mw of electric power for each large machine may be required.

Surface facilities for underground mines are usually not affected by the underground workings and can be designed with more flexibility than the facilities for surface mines. Open pits and their processing and waste disposal facilities must crowd together to minimize distances for transporting materials of all kinds. Large areas may be needed for waste disposal and ore storage near the extraction area. Surface-mining methods generally apply to such ores of commodities such as iron, disseminated copper and gold, limestone, boron, gypsum, clays, and rare-earths. Underground methods are more often used for all vein deposits and for such commodities as silver, gold, tungsten, lead, and zinc.

Uranium Mining

Uranium exploration is typical of most locatable minerals and requires selection of a favorable area, field reconnaissance, land acquisition, target definition, and evaluation. The last items involve drilling and excavation and are done after land acquisition because of the significant increase in exploration costs in the later stages. If the land cannot be acquired and access assured, exploration cannot be justified beyond the preliminary stages.

Preliminary investigations include the study of remotely sensed data. Geologic features such as lineaments and alteration zones can be observed from satellite images. Lower level data, inluding photography and radar

images, can identify smaller features and more subtle differences in color and texture of rock units. Very low level airborne geophysical investigations of gamma-ray emission, gravity, and magnetism complete the indirect methods leading toward selection of favorable prospecting areas. Geological mapping and ground-based studies of geochemistry and geophysics may be required for site selection and may overlap into the field reconnaissance stage of exploration.

Field studies may include soil and water sampling, radiometric investigations, and studies of electrical and physical characteristics of localities and specific targets. These studies may include some drilling and downhole logging.

After property acquisition, further site-specific exploration programs, primarily drilling, lead to the design of mining operations, if the deposit warrants such actions. Surface disturbance would normally be where subsequent mining operations would take place. That is, surface disturbing activities like drilling are more concentrated near the ore body, which is where mining may later occur. Problems could be minimized by careful selection of routes and drill sites and by appropriate clean-up after tests are completed.

Uranium ore may be mined by either open-pit or underground methods. Where the ore zones extend below the water table, removal of water may change the chemical conditions and result in toxic elements being dissolved in the mine water when it is pumped to the surface for disposal. Extensive treatment of mine waters may be required as a component of proper mine design.

Air quality underground and adjacent to uranium mines may be adversely affected by radon decay products. Dust from trucks or from other handling of radioactive ore may concentrate emissions where the dust accumulates. Waste rock from uranium mines can release toxic and radioactive materials which can, in time, enter into groundwater.

Uranium ore is not now being produced in the CDCA. Production would require bringing facilities to the desert for doing at least some ore concentration. There are no concentrating facilities in California.

Dissolving uranium from ore deposits in-place is a technique finding wider application in the uranium industry. There are methods for controlling the spread of chemicals into adjacent soil or groundwater. Solutions derived from leaching operations must be stripped of their values at the place of production.

The Nuclear Regulatory Commission licenses uranium production and requires environmental reports with detailed consideration of the many issues. (Rouse, J. V., "Environmental Considerations of Uranium Mining and Milling," Mining Engineering, October 1978).

MINERAL MATERIAL SALES SCENARIO

The mineral material sales scenario was developed from a study of the "average" material sales contract, which was normally 10,000 cubic yards of material for quarried rock or sand and gravel. Table XIV-3-8 summarizes surface acreage disturbance by stages and cumulatively.

Table XIV-3-8

SURFACE DISTURBANCE FROM MATERIAL SALES SITES

STAGE	Roads (Acre)	Pit/Quarry (Acre)	Cumulative Acreage Used
Exploration	0.50	None	0.50
Development/ Production	0.25	1.5	2.75
Reclamation	0.0	0.0	2.75

Material sales activities on Federal lands are authorized by the Materials Act of July 31, 1947, as amended. Surface management and reclamation of these activities are part of this act, and its subsequent regulations are in 43 CFR 23 and 43 CFR 3600. The State of California also regulates material sales operations under the State Mining and Reclamation Act (SMRA) of 1975.

There are two procedures used by State and local agencies to acquire free salable materials from Federal lands. Under Title 23 USC, which deals with the interstate and defense highway system, a state highway department (e.g., Caltrans) may apply for exclusive materials sales rights-of-way on Federal lands for highway construction and maintenance programs. It is handled through the Secretary of Transportation and bypasses the Bureau material sales system. The material sales sites are in the form of exclusive grants to the State and are not subject to the normal BLM procedures or planning system. This has particular implications for the Desert Plan, especially in Class L. More commonly, BLM issues a free-use permit to the agency, allowing them to remove salable materials in limited amounts for a limited time at a given site. Commercial operators remove salable materials from Federal land under contracts issued by BLM.

The major aspects of typical sand and gravel operations are a pit or trench covering 0.74 to 1.0 acre to a depth of approximately 10 feet. Deposits are predominantly sand or gravel and are located in physiographic areas where erosion and weathering have reworked sediments into deposits where particles are predominately of one size. These areas are normally washes, riverbeds, shorelines, and alluvial fans.

Sites are located as close to use areas as possible due to transportation costs. Typical equipment used includes front-end loaders, dump trucks, water trucks, and personal vehicles. The processing equipment, portable and moved from site to site, consists of conveyor belts, sizing screens, and, occasionally, drying kilns. Equipment is normally set up in the pit itself to minimize handling costs.

Surface reclamation requires that pit slopes or trench slopes be left stable and recontoured at 3:1 to 6:1 (horizontal:vertical). Past experience has shown that vegetation and wildlife return to the reclaimed site within two years after activity ceases.

A rock quarry operation entails the mining of rock in an open pit, using explosives to break the rock. Quarry size is 1 to 2 acres, and the vertical extent is variable, depending on topography. Cliff faces or ledges are preferred for easier access to and easier removal of the rock. Equipment and operational methods are the same as sand and gravel operations.

LEASABLE COMMODITIES SCENARIO

Saline Minerals

The saline minerals scenario was developed with help from saline minerals extraction operators presently active on several dry lake beds in the CDCA. Table XIV-3-9 summarizes surface acreage disturbance by stages and cumulatively.

Table XIV-3-9

SURFACE DISTURBANCE ASSOCIATED WITH SALINE MINING OPERATIONS (ACRES)

STAGE	Roads	Drill Pads	Pipe-lines	Ponds	Plant	Stage Total	Cumulative Total
Exploration	4.33	0.2	0.0	0.0	0.0	4.53	4.53
Development/ Production	8.71	10.0	294.0	1100.00	140.00	1552.71	1557.24
Close Down	0.0	0.0	0.0	0.0	0.0	0.0	1557.24
Residual							140.00

Saline minerals exploration and production on Federal lands is authorized by the Mineral Leasing Act of February 25, 1920, as amended (41 Statute 437). Surface management control is provided by the National Environmental Policy Act of 1969 (42 USG 4332). Regulations in 43 CFR 3500 and cooperative agreements between several Federal agencies, including the Geological

Survey, the Bureau of Land Management, the Forest Service, and the Fish and Wildlife Service, provide for strict surface management controls of a lessee's operations.

A typical search for saline minerals begins with the issuance of a prospecting permit, which carries a preference right to lease if an economic discovery is made. Exploratory activities concentrate on drilling the dry lake beds, using a track road and placing a drill on a 30 by 30-foot open site.

If a discovery is made and development proceeds, a series of wells are drilled into the brine using a 50 by 50-foot pad, which is reclaimed to 25 by 25 feet after the well is completed. Well spacing is variable depending on the size of the brine pool encountered, but averages one well per 80 acres.

Brines are conveyed via 10 to 12-inch pipelines to evaporation ponds, where the salt is removed by precipitation and the brines are further concentrated. A 20 to 24-inch pipeline carries the brines from the ponds to the chemical plant for processing. A road net connects the wells to each other, and the pipelines follow the roads. All installations, except the plant, are located on the dry lake bed; the salt crust will not support the weight of the plant.

Reclamation is easily accomplished. The winter rains raise the brines to the surface, and each new layer of salt is laid down (up to 8 vertical inches per year). This causes all roads and drill pads to be filled in, and the dry lake bed is restored to a homogenous surface. The lessee is faced with reestablishing his roads every year. Once the evaporation ponds are backfilled and smoothed over, all traces of the operation will be removed by natural processes within one year.

Geothermal Resources

The geothermal resources scenario was developed from the official documentation of the history of Magma Power Company's 10 Mw geothermal power plant in the East Mesa area of Imperial County, California. It is the only completely documented, currently operating geothermal power system in the California Desert. Table XIV-3-10 summarizes the surface disturbance by stages and cumulatively. Map XIV-3-1 indicates major units of the plant in relation to its site along the East Highline Canal.

Geothermal operations on Federal lands are authorized by the Geothermal Steam Act of December 24, 1970 (PL 91-5810). Strict surface management control of all geothermal activities is provided by the Act and its subsequent regulations in 30 CFR 270 and 271, 43 CFR 3200, and the Geothermal Resource Operations Orders (GROs) issued by the U.S. Geological Survey. All lessees and operators must comply with these regulations or face punitive action, up to and including lease termination for severe noncompliance. GRO #4 concerns the environmental controls and safeguards on Federal geothermal leases.

Table XIV-3-10

SURFACE DISTURBANCE (ACRES) ASSOCIATED WITH GEOTHERMAL OPERATIONS [1]

STAGE	Roads	Drill pads	Pipe-lines	Ponds	Power Plants	Power Lines	Stage Total	Cum. Total	% of Lease [2]
Initial Exploration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Preliminary Exploration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geophysical Surveys	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exploration Drilling	2.05	3.45	0.0	0.62[3]	0.0	0.0	5.5	5.5	0.29
Field Developemnt	0.33	4.83[4]	2.05	37.19[5]	0.92	0.92	46.24	51.74	2.75
Production and Operation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.74	'2.75
Close Down and Reclamation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.74	2.75

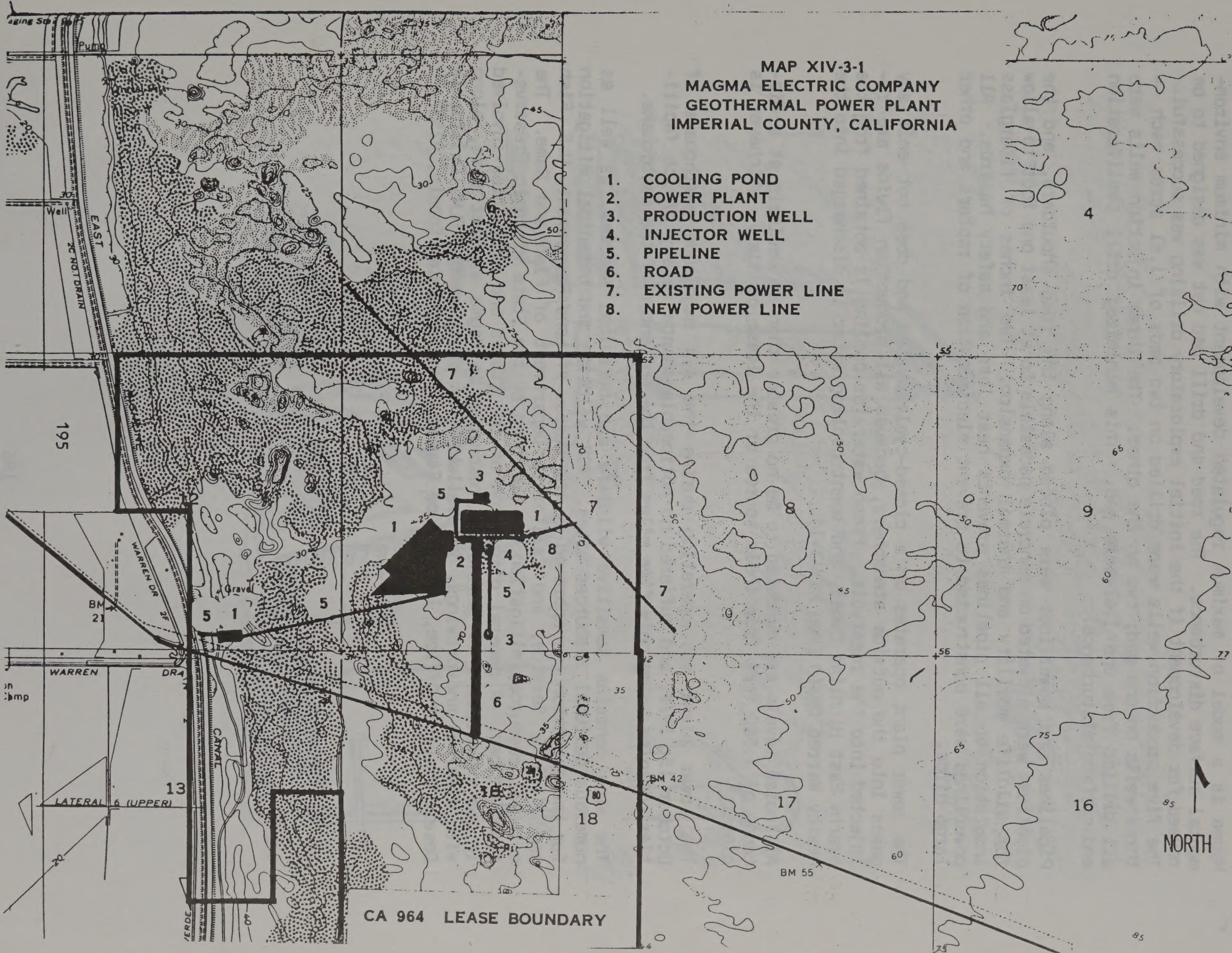
1 Based on Magma Power Company's 10 Mw Power Plant, Imperial County, California.

2 Lease area is 1,880.0 acres.

3 Included in Pad Area.

4 1.38 is the actual additional disturbance after exploration drilling.

5 Does not contain the 0.62 acres of temporary drill sumps on the pads.



MAP XIV-3-1
MAGMA ELECTRIC COMPANY
GEOTHERMAL POWER PLANT
IMPERIAL COUNTY, CALIFORNIA
1. COOLING POND
2. POWER PLANT
3. PRODUCTION WELL
4. INJECTOR WELL
5. PIPELINE
6. ROAD
7. EXISTING POWER LINE
8. NEW POWER LINE
CA 964 LEASE BOUNDARY
NORTH
WARREN DR
LATERAL 6 (UPPER)
CANAL
EAST
Pump
Well
BM 42
BM 55

Magma is a model of maximum regulated development with minimum environmental surface disturbance. The road and drill pad net was designed to be reused for development if the initial exploratory drilling was successful. The five production wells were drilled on two pads of 1.61 acres each -- three wells on one pad; two on the other. The three injection wells were all drilled from one 1.61-acre pad. This minimized drill proliferation and surface disturbance.

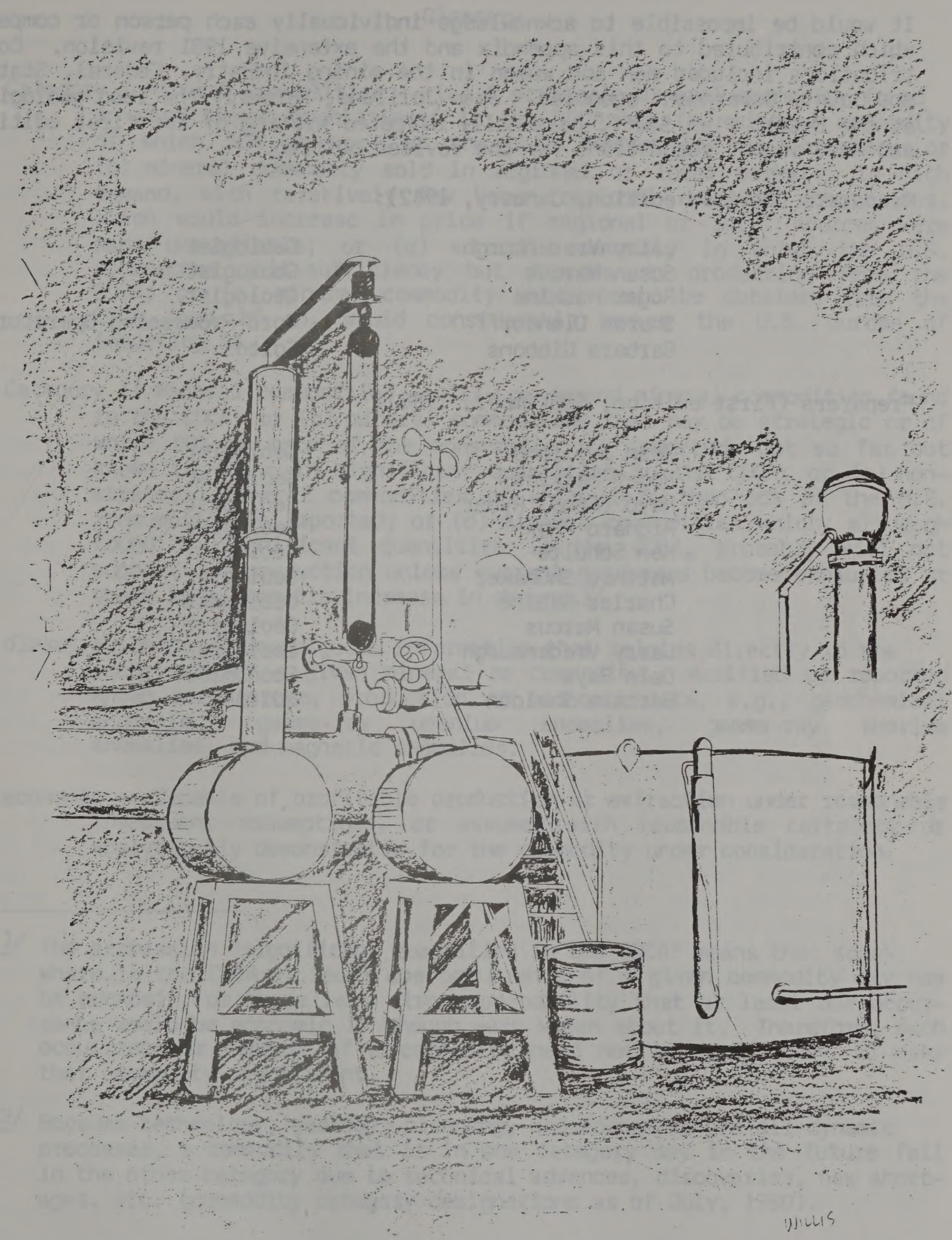
Pipelines and powerlines were placed along the road shoulders, and the pipelines were elevated on concrete pedestals to at least one foot to allow for wildlife mobility and thermal expansion. Two inches of fiberglass insulation on all pipelines prevents heat loss and safety hazards. All powerlines were constructed to prevent electrocution of raptors and other large birds.

The power plant operates on a closed-cycle system and does not emit any gases into the outside atmosphere, because all production fluids are reinjected into the reservoir. Fresh water for cooling is obtained from the nearby East Highline Canal, and spent cooling water is discharged into the nearby Warren Drain (Map XIV-3-1).

All noise levels are mandated to be no greater than 65 decibels at a distance of 1,500 feet from their source or the lease boundary, whichever is closer.

The power plant was operating during the 6.4 magnitude earthquake of October 15, 1979, and suffered no noticeable damage to any of its facilities, despite being only five miles from the epicenter of the earthquake.

The area contains sensitive wildlife and botanical species, as well as numerous cultural resources sites. All wildlife and botanical mitigation for the operation was approved by the Bureau of Land Management, U.S. Fish and Wildlife Service, and California Department of Fish and Game. The cultural resources mitigation was approved by the State Historic Preservation Officer. A general discussion of the stages and activities involved in the development of geothermal resources by Magma at East Mesa, along with diagrams and drawings, is available for study at the BLM, California Desert District Office, 1695 Spruce Street, Riverside, California, 92507.



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It would be impossible to acknowledge individually each person or company which contributed to this appendix and the extensive 1981 revision. Contributions included men and women in the mining industry, Federal, State, and County Government agencies. Jean Juilland, formerly the lead geologist at the Desert Plan Staff, personally directed writing of the first edition and made cogent suggestions for the revised edition.

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Part 4

Glossary

Category I Mineral Commodities -- (a) A strategic mineral commodity found in significant quantities[1] in the CDCA: or (b) mineral commodity of which 50% or more of the U.S. consumption is imported; or (c) mineral commodity sold in regional or local markets, in high demand, with relatively few known regional economic occurrences, which would increase in price if regional or local sources were made unavailable; or (d) mineral commodity in which the U.S. approaches self-sufficiency but depends on production from the CDCA; or (e) mineral commodity which could be obtained from the CDCA, and if so, would considerably reduce the U.S. burden of importing it.

Category II Mineral Commodities -- (a) Low demand mineral commodities found in the CDCA; or (b) mineral commodities that may be strategic or of which 50% or more of the consumption is imported, but so far not known to occur in significant quantities in the CDCA; or (c) non-strategic mineral commodities of which less than 50% of the U.S. consumption is imported; or (d) mineral commodities which, although found in significant quantities in the CDCA, probably will not support new production unless current producers become exhausted or there is a dramatic increase in demand.[2]

direct evidence -- Unambiguous information that relates directly to the occurrence of a given mineral or commodity. Verified or reported known occurrences, production or economic data, e.g., geochemical anomalies, gamma-ray uranium anomalies, gamma-ray thorium anomalies, and magnetic anomalies.

economic -- Capable of profitable production or extraction under reasonable investment assumptions, or assumed with reasonable certainty or analytically demonstrated for the commodity under consideration.

1/ The expression "significant quantities in the CDCA" means that somewhere in the CDCA at least one occurrence of a given commodity may now be economic, or there is a strong probability that at least one occurrence would be economic if enough were known about it. Therefore, each occurrence or deposit of a commodity need not be significant to make that commodity significant.

2/ Because technology, geology, planning, and economics are all dynamic processes, a commodity that is in one category may in the future fall in the other category due to technical advances, discoveries, new shortages, etc. (commodity category designations as of July, 1980).

favorable geologic environment -- Areas where the geologic setting, i.e., lithology (rock types), structure, location, mineral occurrences, and/or any other forms of direct or indirect evidence, indicates potential for mineral deposition. The classification system makes a distinction between mineral occurrences from favorable geologic environments without known occurrences.

indirect evidence -- Information about a geologic environment that does not directly relate to the occurrence of any specific mineral commodity. The information includes indicators of mineralization, such as geostatistical maps, expert panel maps, lineament maps, gamma-ray potassium anomalies, Bouguer anomalies, tonal anomalies, claims, and potentially favorable lithologies (lithologies similar to those hosting mineralization in other areas).

intermittent producer -- Removal of minerals or energy resources on a noncontinuous basis; operations at which removals occurred at least once within the past two years.

Known Geothermal Resource Area (KGRA) as classified by the USGS -- "...an area in which the geology, nearby discoveries, competitive interests or other factors would... engender a belief in men who are experienced in the subject matter that the prospects for extraction of geothermal steam or associated geothermal resources are good enough to warrant expenditures of money for that purpose." Code of Federal Regulations (CFR), Title 43, Group 3200.0-5 (cited as: 43 CFR 3200-5).

Known Geologic Structure (KGS) -- "A known geologic structure is technically the trap in which an accumulation of oil or gas has been discovered by drilling and (is) determined to be productive, the limits of which include all acreage that is presumptively productive." (43 CFR, 3100.0-5).

leasables -- Mineral and energy resources for which lands can be leased. These commodities are defined and regulated by U.S. laws, 43 CFR Groups 3100, 3200, 3500, and other regulations. Oil, gas, geothermal, and all sodium and/or potassium compounds are among examples of leasable resources found in the CDCA.

locatables -- Minerals subject to the General Mining Law of May 10, 1872, as amended. Metallic minerals and many nonmetallic minerals, such as zeolites or barite, are locatable; 43 CFR 3800 pertains to locatable minerals.

mineral deposit -- A natural concentration of a mineral, minerals, or a chemical element (e.g., gold) in sufficient quantities and of such quality as to permit inferring profitable extraction.

net export -- Export of a commodity in excess of import.

ore deposit -- A mineral deposit that is currently mined or that could be mined at a profit.

Potential Geothermal Resource Area (PGRA) -- Equivalent to "prospectively valuable" as classified by USGS.

prospectively valuable -- USGS classification of leasable mineral commodity. Areas geologically similar to currently producing deposits "...inference being that similar deposits are probably present" in prospectively valuable areas. This designation includes known occurrences where the extent and quality "cannot be ascertained."

resource[1/] -- Concentration of naturally occurring solids, liquids, or gaseous material in or on the earth's crust in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible. Modifiers below are listed in ascending order of geologic assurance.

inferred -- Estimates based on an assumed continuity from measured and/or indicated resources for which there is geologic evidence.

indicated -- Quantity, grade, and/or quality computed from information similar to that used for measured resources, but sites for inspection, sampling, and measurement are farther apart or less adequately spaced; degree of assurance, although lower than that for measured resources, is high enough for continuity between points of observation to be assumed.

measured -- Quantity, grade, and/or quality computed from dimensions revealed in outcrops, trenches, workings, or drill holes and geologic character is so well defined that size, shape, depth, and mineral content of a resource body are well established.

demonstrated -- Term for the sum of measured and indicated.

reserves -- Part of resource that could be economically extracted or produced at time of determination; term reserves need not signify that extraction facilities are in place and operative.

marginal reserves -- Portion of the reserves that, at the time of determination, borders on being economically producible; essential characteristic is economic uncertainty. Included are resources that would be producible, given changes in economic or technologic factors.

salables -- Mineral materials as covered and defined in 43 CFR 3600: sand, gravel, pumice, cinders, roofing granules, and crushed rock are examples of salable materials found in the CDCA.

1/ All definitions of resources and reserves are adapted from Mineral Commodity Summaries, 1980, U.S. Bureau of Mines.

strategic minerals -- Mineral resources included on a list of minerals and other commodities stockpiled by the Federal Government. The list is compiled annually by the Federal Emergency Management Agency.

Units of Measurement

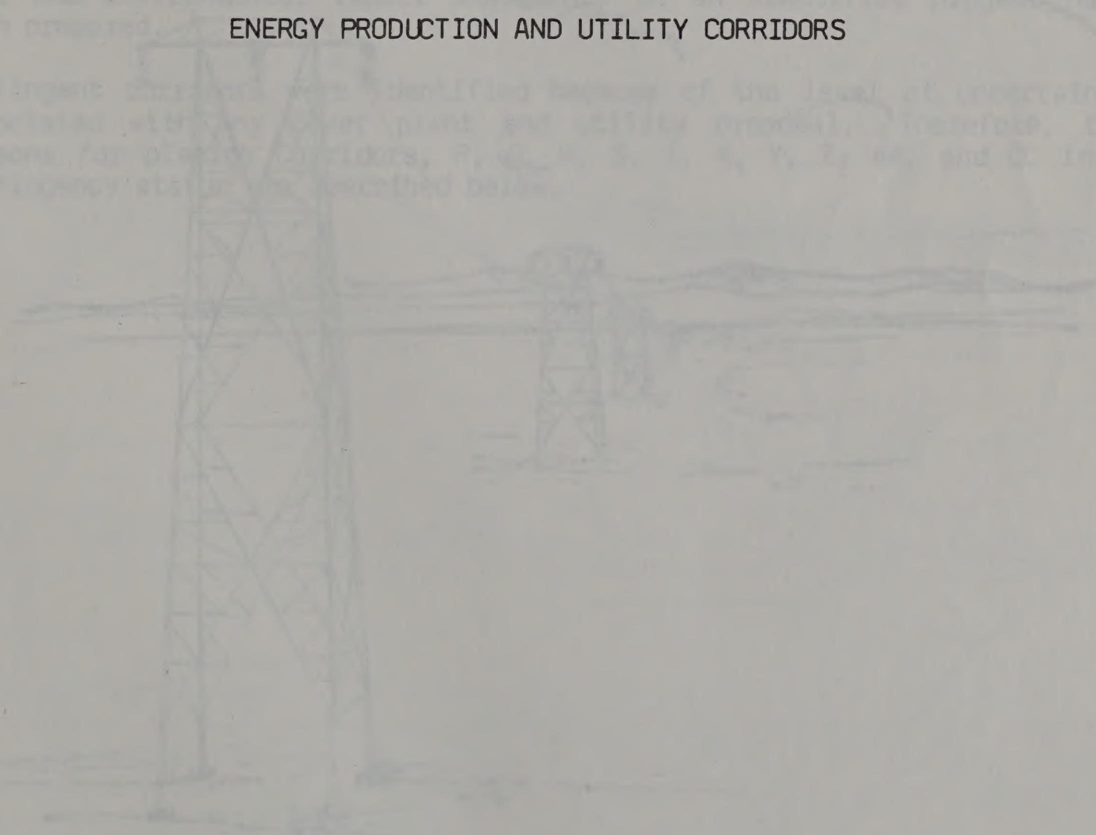
kilogram (kg) -- 2.2046 pounds
metric ton (mt) -- 1,000 kg: 2,204.6 pounds
short ton (st) -- 2,000 pounds
long ton (lt) -- 2,240 pounds
short ton unit (stu) -- 1% of a short ton: 20 pounds
long ton unit (ltu) -- 1% of a long ton: 22.4 pounds
troy ounces -- 1.09714 ounces avoirdupois
barrel (bbl) -- 42 gallons
cubic foot (ft^3) -- 1 ft^3
ounce and pound -- U.S. avoirdupois (16 oz/lb)

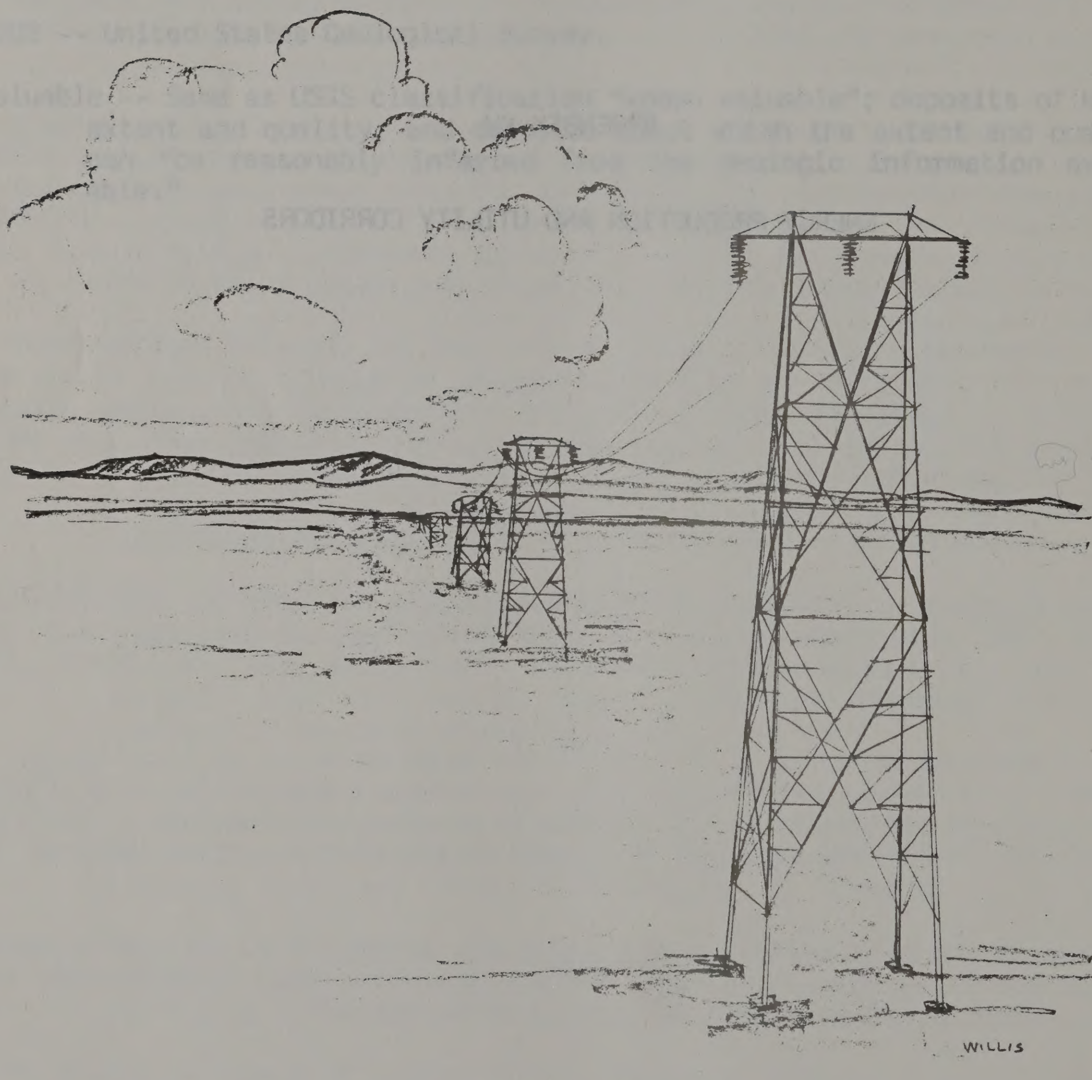
USGS -- United States Geological Survey.

valuable -- Same as USGS classification "known valuable"; deposits of known extent and quality, and deposits about which the extent and quality can "be reasonably inferred from the geologic information available."

APPENDIX XV

ENERGY PRODUCTION AND UTILITY CORRIDORS

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APPENDIX XV

ENERGY PRODUCTION AND UTILITY CORRIDORS

Contingent Corridors

Corridors with Potential for Future Use

CORRIDOR IDENTIFICATION

Sixteen utility planning corridors are identified in the Energy Production and Utility Corridors Element of the Plan. Additionally, ten more corridors (P, Q, R, S, T, AA, CC, W, Y, Z) have been identified as having some potential for use in the future, should project status associated with the proposed 16 corridors change. These ten are referred to as "contingent corridors" and are described in Table XV-1 and shown on the map in this appendix. These corridors are not shown on the Plan. Contingent corridors may be brought forward into the Plan after simultaneous Plan amendment and environmental impact statements on an identified project have been prepared.

Contingent corridors were identified because of the level of uncertainty associated with any power plant and utility proposal. Therefore, the reasons for placing Corridors, P, Q, R, S, T, W, Y, Z, AA, and CC in a contingency status are described below.

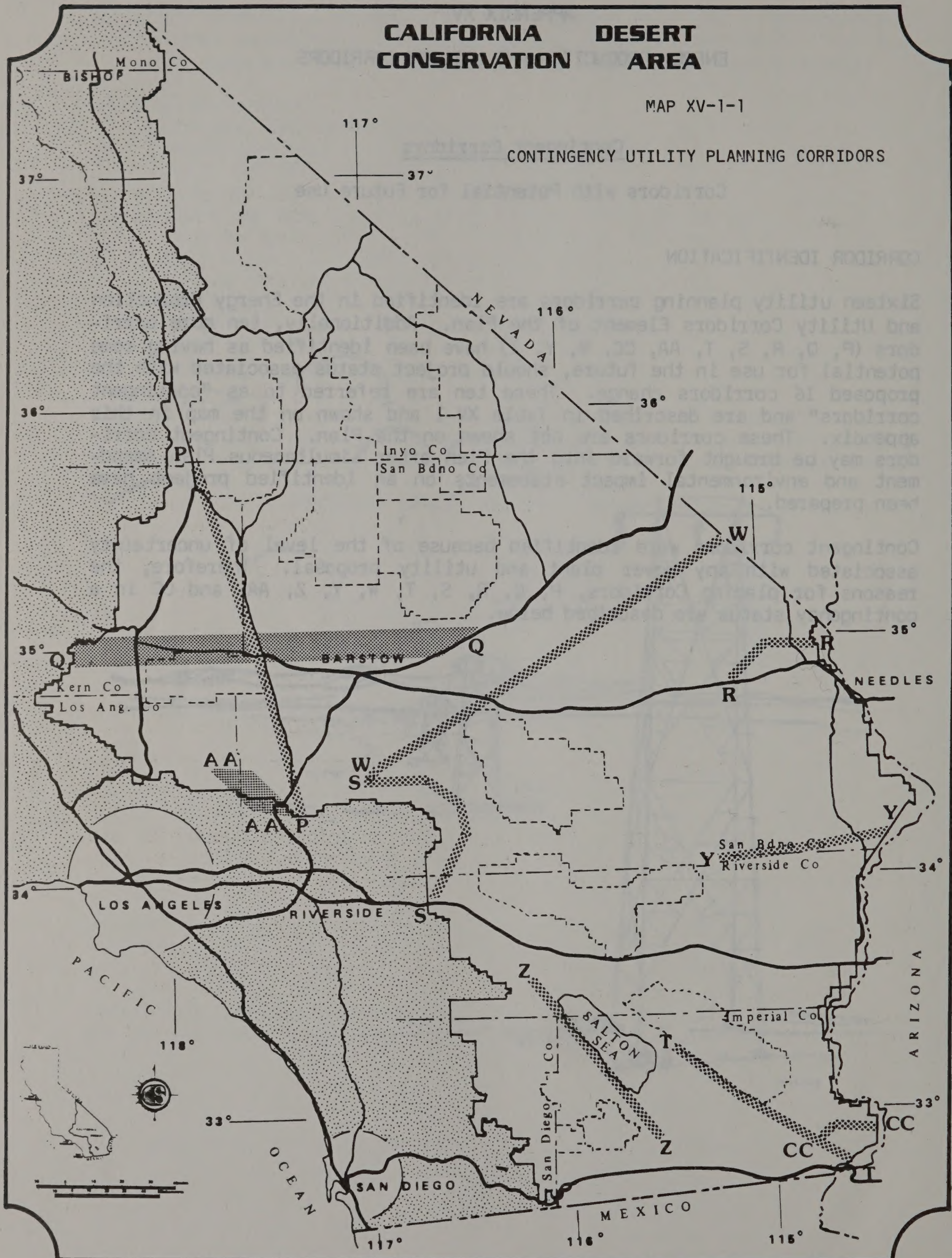
CALIFORNIA DESERT CONSERVATION AREA
MAP XV-1-1
CONTINGENCY UTILITY PLANNING CORRIDORS
Mono Co
BISHOP
NEVADA
Inyo Co
San Bdno Co
BARSTOW
Kern Co
Los Ang. Co
NEEDLES
San Bdno Co
Riverside Co
LOS ANGELES
RIVERSIDE
PACIFIC
OCEAN
SALTON SEA
Imperial Co
San Diego Co
SAN DIEGO
MEXICO
ARIZONA
P
Q
W
R
AA
S
Y
Z
T
CC
117°
116°
115°
118°
37°
36°
35°
34°
33°

TABLE XV-1

CONTINGENT CORRIDORS

CORRIDOR	Width	Identified Use
P	2 miles	2/115-Kv power lines 12-in. pipeline Coaxial cable
Q	5 miles	Coaxial cable
R	2 miles	Telephone line
S	2-5 miles	None
	5 miles	None
T	2 miles	12-in. pipeline
W	2 miles	500-Kv power line 2/230-Kv power line
Y	2 miles	Aqueduct Telephone line
Z	2 miles	92-Kv power line
AA	4 miles	2/500-Kv power lines
CC	2 miles	1/500-Kv power line

CORRIDOR P

Corridor P contains existing facilities. The anticipated additional use of this corridor is predicated upon new energy sources being located north of or in the northerly sector of the California Desert Conservation Area.

CORRIDOR Q

This corridor is seen as a contingency corridor for the transmission of energy from eastern generating sites. While this corridor is not specifically associated with any particular project, it could be utilized in connection with the Allen-Warner Valley Energy System or other generating facilities currently under study.

CORRIDOR R

There are existing electric transmission facilities within this corridor. It is an alternate corridor for the Allen-Warner Valley Energy System presently being reviewed by the California Public Utilities Commission. This corridor could prove to be invaluable for other transmission facilities which would be associated with future projects.

CORRIDOR S

Corridor S provides one of the few viable alternatives to the critical corridor through the Banning Pass area. There are existing transmission facilities within portions of this corridor.

CORRIDOR T

Corridor T is an alternative for the transmission of energy generated by either geothermal or conventional power plants. This corridor, which is an alternative to Corridor Z, is improved with existing electric transmission facilities.

CORRIDOR Z

This corridor may be useful in transmitting energy from geothermal and possible solar generators associated with the Salton Sea if these become viable sources in the future.

CORRIDOR AA

This corridor, which contains existing electric transmission facilities, is almost totally within private lands. Corridor AA completes an important link in the network of transmission corridors.

CORRIDOR W

Southern California Edison Company and the Public Utilities Commission are considering this corridor. Edison is proceeding with plans to build a power plant in Lucerne Valley. Corridor W would serve the site as a means for delivering electricity to customers in the Los Angeles basin.

CORRIDOR Y

Southern California Edison Company and the California Public Utilities Commission requested this corridor since it would serve the Rice Site of the California Coal Project currently under review by the Energy Commission.

CORRIDOR CC

San Diego Gas and Electric Company requested this corridor as a possible alternative for their Arizona Interconnection Project from Yuma to the San Diego area. The corridor will extend across the north boundary of the Quechon Indian Reservation.

GPO 589-098/314

CORRIDOR [illegible]

There are existing electric transmission facilities within this corridor. It is an alternate corridor for the [illegible] Valley Energy System currently being reviewed by the California Public Utilities Commission. This corridor could prove to be acceptable for other transmission facilities which would be associated with future projects.

CORRIDOR A

Corridor A provides one of the few viable alternatives to the critical corridor through the Banning Pass area. There are existing transmission facilities within portions of this corridor.

CORRIDOR 1

Corridor 1 is an alternative for the transmission of energy generated by either geothermal or conventional power plants. This corridor, which is an alternative to Corridor 2, is [illegible] with existing electric transmission facilities.

CORRIDOR [illegible]

This corridor may be useful in transmitting energy from geothermal and possible solar generators associated with the Salton Sea if these become viable sources in the future.

CORRIDOR AA

This corridor, which contains existing electric transmission facilities, is almost totally within private lands. Corridor AA completes an important link in the network of transmission corridors.

CORRIDOR W

Southern California Edison Company and the Public Utilities Commission are considering this corridor. Edison is proceeding with plans to build a power plant in Lucerne Valley. Corridor W would serve the site as a means for delivering electricity to customers in the Los Angeles basin.

CORRIDOR [illegible]

Southern California Edison Company and the California Public Utilities Commission proposed this corridor since it would serve the Rice Site of the California Coal Project currently under review by the Energy Commission.

CORRIDOR [illegible]

San Diego Gas and Electric Company requested this corridor as a possible alternative for their Arizona interconnection project from Yuma to the San Diego area. The corridor will extend along the south boundary of the Quechan Indian Reservation.